THE TECH ENGINEERING NEWS

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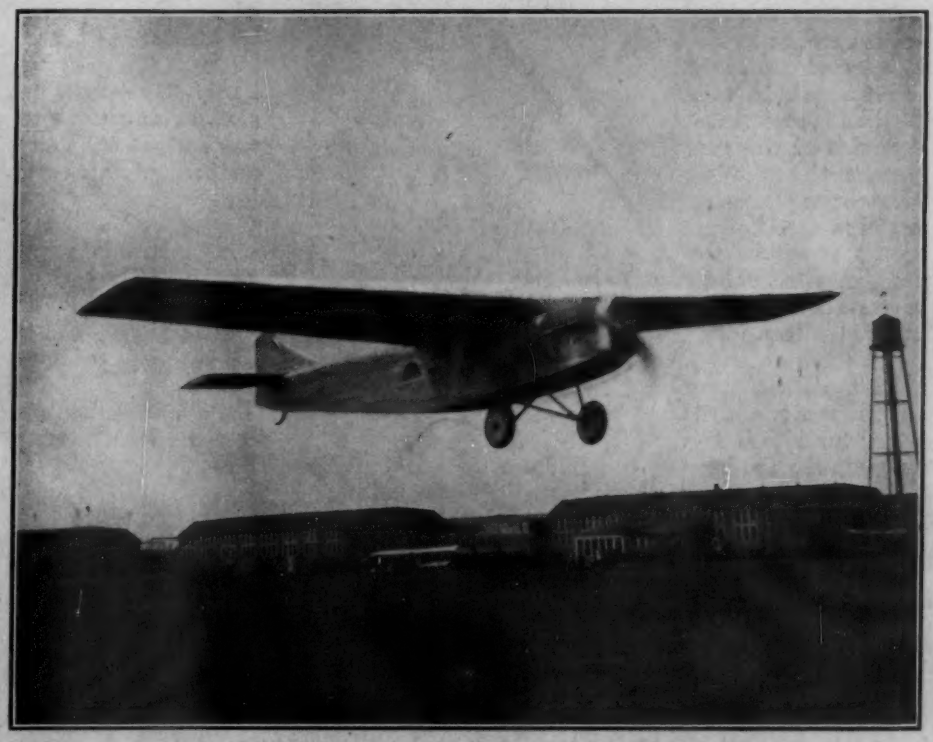

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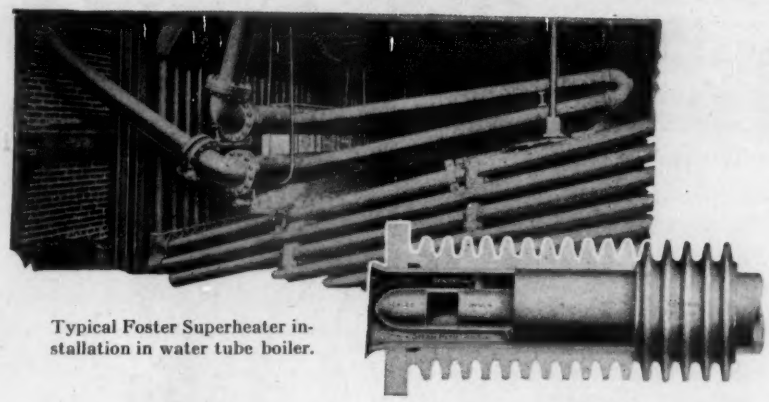

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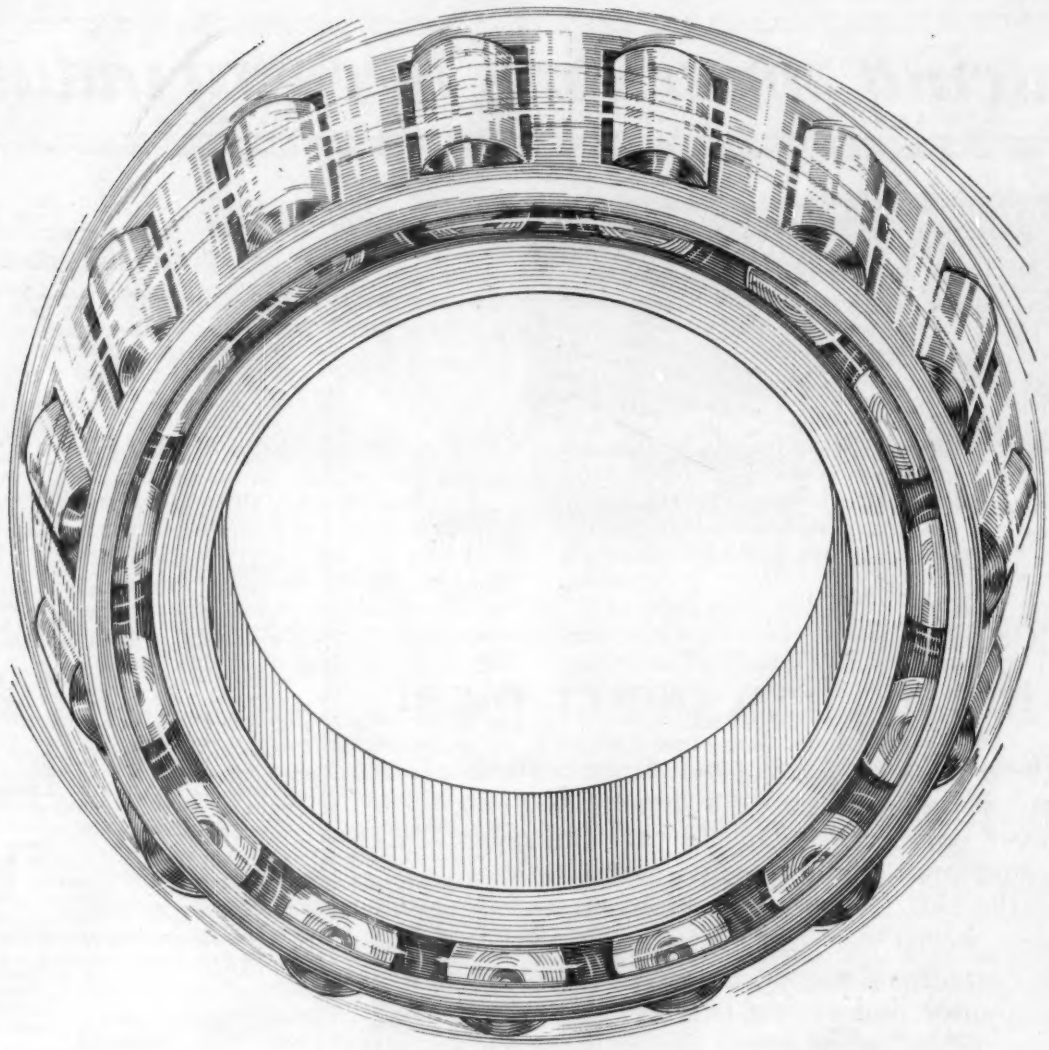

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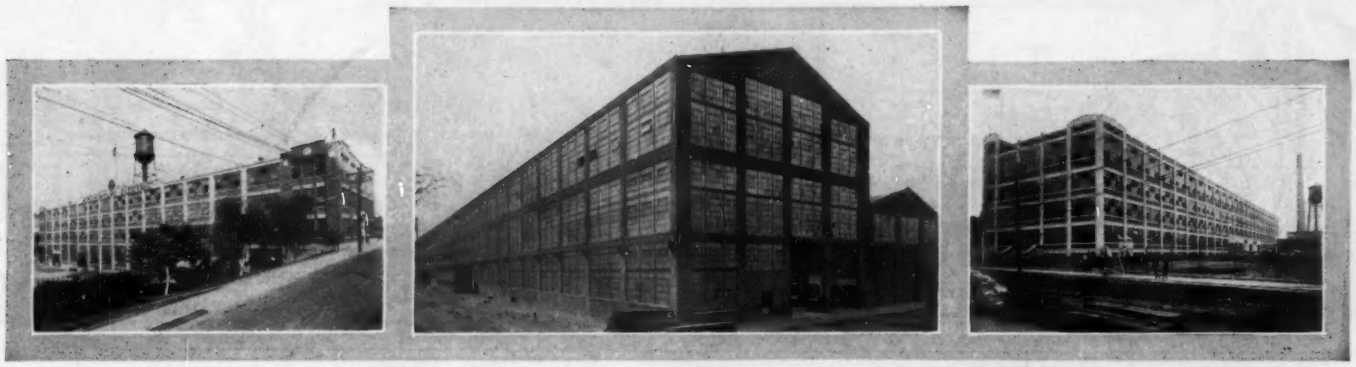

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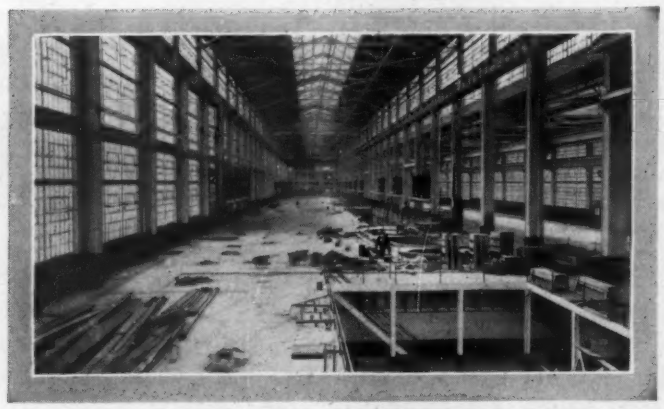

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VOLUME VI JANUARY, 1926 NUMBER 6

The New Course in Ship Operation

A description of the course to be given in the Department of Naval Architecture and Marine Engineering as Option 2 of Course XIII

By LAWRENCE B. CHAPMAN, '10

Associate Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology.

A NEW course has been inaugurated at the Institute to prepare men to enter the fields of ship operation and management and to engage in other maritime pursuits. This course is a combination of science, engineering, economics, and engineering administration, and will be given in the Department of Naval Architecture and Marine Engineering as Option 2 of Course XIII.

Up to the present time the shipping companies have not made it a regular practice to take college men or engineering graduates into their organization to train for the responsible positions in ship agreement. Many of the leading steamship companies in this country have encouraged the Institute in the establishment of this course, and no doubt most of them will be willing to start graduates of this new course in their organization.

Several American universities are giving courses which cover the purely business side of foreign trade, shipping, and ship management. Lehigh University, however, was the first school to recognize the need of a combined training in engineering and business administration to prepare men for the operating of ships, and such a course of study was established there in 1919. This course at Lehigh has recently been given up, and the Institute is now the only school in this country, and probably in the world, that offers a combined training in business studies, engineering, and the various branches of naval architecture and marine engineering, to prepare men for the economic operation of our merchant marine.

As the schedule of studies will show, the new course is a specially broad one, combining as it does the basic sciences, general studies, economics, business administration, the fundamentals of mechanical and electrical engineering, and a thorough technical study of ships, marine engineering, and ship operation.

In the present condition of our merchant marine the demand for men is, of course, not large, especially in the field of foreign trade. The expansion of our merchant marine and international competition, however, will demand that more and more attention be given to the design and economic operation of ships, and the future opportunities of men who have had the proper training and experience in this work should be especially good. In addition to foreign trade, our large coastal and intercoastal shipping and the future transportation on our inland waterways offer openings for men trained in this course. Besides situations with the ship operating companies in technical and administrative positions, graduates should find openings in marine insurance, admiralty law, and other allied lines. They are not barred from entering the fields of ship and engine building, although the regular Course XIII men will be better qualified for the purely technical positions dealing with the design and construction of ships and engines. It must be borne in mind that while the openings for men graduating in this new course are not as great as in many other branches of engineering, the supply of men will be small and the field a new one for engineering graduates.

The first and second years of the new course are very little different from the regular course in Naval Architecture and Marine Engineering. The only marked difference is the introduction of accounting and political economy in the second year in place of the shop work, which is postponed until later in the course. In the third and fourth years the new course diverges radically from Course XIII. Business studies and courses in economics are introduced, and the time devoted to engineering and professional work is correspondingly reduced. The courses in economics are in most cases the same as those given to the students in Business Administration. These include Accounting, Banking, Corporation Organization, Corporation Finance and Investments, Statistics, Industrial Relations, Business Law and Cost Accounting. The basic and fundamental engineering studies such as chemistry, physics, drawing, heat engineering, applied mechanics, and electrical engineering receive as much time in the new course as in the regular Course XIII. Ship construction, naval architecture, and ship design are taken up in the new option, but not as thoroughly as in the regular course. These courses are laid out so as to give the student a thorough working knowledge of the technical and economic aspects of ship design and construction, but more from the point of view of the owner and operator than from that of the designer and builder. As a thorough knowledge of a ship's machinery installation is absolutely essential to the ship operator, who must have a large share in the selection and economic operation of the ship's propelling machinery, marine engineering is given a prominent place in the new schedule of studies. An introductory course is given in the third year followed by a more complete study of steam turbines, Diesel engines, and auxiliary machinery in the fourth year. The drawing room work in marine engineering will be devoted more to the selection and

(*Continued on page 252*)

Training the Electrical Engineer

A discussion of the educational activities and systems of the Bell System for the Development of a Trained Personnel

By Dr. J. O. Perrine *and* O. W. Eshbach

Respectively of the General Information and Personnel Dept., American Telephone and Telegraph Co., New York City.

THE ever-increasing demand for the extension of telephone service and the creation of new facilities in America's nation-wide telephone industry involve far-reaching, complex, and difficult problems. Among them, and by no means of minor importance, is the problem of developing an adequate and well-trained personnel. To develop and manufacture equipment, to construct, maintain, and operate the plant, and conduct the business so as to give good service at a reasonable rate, provide a fair return to the investor and attract new capital, demands thorough knowledge of the fundamental laws of engineering and business.

One's education in college is an opportunity which, if it is to be utilized to the fullest extent, requires the study of the fundamentals of engineering and business, rather than the specific practices of a particular industry. In a recent statement, Dr. F. B. Jewett, Vice-President of the American Telephone and Telegraph Company, in charge of development and research work, made some pointed comments in this regard:

"The telephone industry with which I am connected is a highly technical one, which is based on physics and chemistry and mathematics; but so are many of the big industries in our country, and the more I see of them, the more convinced do I become that the directors of these industries, in the future, are going to be drawn more and more from men who have a thorough grounding in the fundamentals on which the industries are based. In the old days it was not so; but each day, as we go on now, it becomes more clearly apparent that because the industries are technical, because they are based on fundamental science, they must be guided by men who have a thorough appreciation of the fundamentals, because business is hardly more than mixing the dollars and cents with physics and chemistry and mathematics.

"It seems to me that if the engineering schools of the future are going to perform their function for the industries, they have got to get closer to the proposition of teaching and really inculcating the fundamentals. Let the matter of trying to make executives go if you will. The men of executive ability will come to the fore in the general run of things, I think, provided the Lord gave them the right human traits and provided they have a thorough grounding in the fundamentals."

At the outset let us visualize the field of endeavor to which the young engineer entering telephone work must devote himself. In many cases of electrical transmission, the engineer is concerned with the delivery of power itself. On the other hand, in the telephone problem, the commodity delivered is speech, and the delivery of electrical power is only a means to this end. In regarding communication as the commodity, a vital phase of the problem is wave form. For the proper reproduction of speech sounds, the wave shape of the electric current starting out from the calling subscriber's station must be transmitted with sufficient identity to give an intelligible and natural sound to the distant subscriber. The frequencies transmitted necessarily cover a wide range. The important components of the complex waves which constitute speech extend from 200 cycles to well over 2000 cycles per second. Even the components from 3000 to 4000 cycles contribute markedly to the intelligibility of speech. The telephone engineer, however, is concerned with a far wider band of frequencies than those of the voice, for in his direct-current telegraph, carrier telephone, carrier telegraph, and radio systems he utilizes a great electrical spectrum extending from zero frequency to over 100,000,000 cycles per second.

This article is the second of a series to discuss the future of the technical graduate in the various professional fields, and the training-schools in those fields. It is hoped that this series will be of assistance to the men of the senior class who are to be confronted with the problem of deciding just what field of activity they will enter upon graduating.

This article is of particular interest, since Dr. S. W. Stratton, President of the Institute, has just recently announced a five-year co-operative course in communication engineering with the Bell Telephone System. The primary purpose of this course is to afford to students such a combination of general and scientific professional training as will fit them to take leading positions as engineering scientific experts. All phases of the communication will be covered in the course. Operating, management, and maintenance experience will be furnished by the New York Telephone Company of New York; research and development experience by the Bell System Laboratories, also at New York; and manufacturing practice by the Western Electric Company at its Kearny plant.

The third article of the series, to appear in the February issue, is "The Technical Graduate in the Patent Field," by Karl Fenning, Patent Lawyer, formerly Assistant Commissioner of Patents.

The mechanical and electrical problems which arise in telephone engineering from the transmission of a wide range of frequencies over circuits that are complex because of their great electrical length, their inductive interrelations, and the number of services which a single pair of wires is required to render, involve in their solution an extensive knowledge of the fundamental sciences of physics and mathematics. In addition, the problems have the economic aspects which constitute such an important factor in all engineering problems, and which in large measure differentiate the work of the engineer from that of the scientist.

Co-ordinated with the problems of electrical transmission, the telephone engineer has complex signaling and switching problems. One might enumerate four essential factors in establishing a telephone circuit between two subscribers:

1. The transmitter and the receiver at each subscriber's station — the generator and motor, as it were.
2. The signaling arrangement at both the subscribers' stations and the central office.
3. The switching arrangements within the central office.
4. Speech transmission over the connecting line.

If, in such a telephone circuit, the signaling system fails to function, an efficient transmitter and receiver are of little use; if one has an inefficient transmitter and receiver, the advantages of a connecting wire system with splendid transmission characteristics are wasted; or if the switching arrangements in the central office cannot connect two subscribers, the entire network of apparatus and connecting wire has little value.

During 1924 the Bell Telephone System set up and took down over 18,000,000,000 connections between its 15,000,000 owned and connecting telephones. Through about 40,000,000 miles of wire over 50,000 individual cities and towns were served by its thousands of central offices. The book value of its assets, consisting principally of plant — its buildings, pole lines, switchboards, repeater stations, cables, etc. — is about $2,600,000,000. During the present year, gross additions to plant amounting to over $350,000,000 will be made and over 800,000 telephones added. To render nation-wide and economical service, two conditions must be continuously met: first, the existing plant must be efficiently maintained and operated; and second, the new plant must be so designed as to give both uninterrupted service and the maximum increase in service.

Organization of the Bell System

Approximately 98 per cent of the telephones in the United States can be reached over the lines of the Bell System, about 70 per cent being owned by

Bell Companies and the remainder by connecting companies. The Bell System includes the American Telephone and Telegraph Company, twenty-five Associated Operating Telephone Companies, the Western Electric Company, Incorporated, and the Bell Telephone Laboratories, Incorporated.

The American Telephone and Telegraph Company, the parent company of the Bell System, maintains general staff organizations furnishing expert advice and assistance to the Associated Companies in connection with development, research, operation, engineering, patent and legal matters, accounts, finance, and administration. Through the Long Lines Department it owns and operates the long-distance lines connecting the territories of the various Associated Companies. It also owns over 90 per cent of the voting stock of the Associated Companies and practically all that of the Western Electric Company.

The Associated Operating Companies own and operate the telephone plant furnishing local and toll service in their respective territories. For example, this service in Boston is given by the New England Telephone and Telegraph Company.

The Western Electric Company manufactures the telephone apparatus and acts as the purchasing, distributing, and supply agency of the System, maintaining large factories at Hawthorne, Chicago, and Kearny, N. J.

The Bell Telephone Laboratories, Incorporated, owned and administered jointly by the American Telephone and Telegraph Company and the Western Electric Company, maintain and operate the research laboratories of the Bell System, it being the largest organization in the world devoted exclusively to research and development work.

Although all of the companies in the Bell System are related to the American Telephone and Telegraph Company through stock ownership and license or supply contracts, and, with it, make up a co-ordinated national System, all of them have complete organizations of their own, and, within broad lines of System policy, carry full responsibility in their own territories or for their distinctive functions. For the trained employees of the System this form of organization combines the advantages of a company of moderate size and a very large organization.

In the Bell System, therefore, there are many different kinds of telephone engineers, such as the commercial engineer, engaged in population surveys and formulating estimates as to the trend and growth of various industries, so as to foretell their effect on population growth and concentration, and the research engineer, engaged in studies of speech and hearing. There are also traffic engineers, charged with the operation of the network of miles of wire covering the country, who must study the conditions under which circuits and switchboards are used and how best to adapt them to the varying loads, find improved ways of dispatching traffic, and measure and maintain the high standard of accuracy with which it is handled. There are plant engineers, concerned with the installation and maintenance of the physical property of the Bell System, which now represents an investment of about two and a half billion dollars. There are the manufacturing engineers, who must both steadily improve the methods and reduce the cost of making the present designs of apparatus, and develop satisfactory processes for making new types. There are development engineers, who must work in close co-operation with the plant and traffic people on the one hand, to ascertain their practical needs, and with the research and development laboratories on the other, to see that full advantage is taken of its developments and discoveries.

Training Courses Necessary for Development and Maintenance of Adequate Personnel

In the Bell System each year hundreds of college men take up their work. These young graduates, some trained in engineering, and some in physics, in chemistry, accounting, economics, etc., must acquire the basis for later co-operation, team-play, and an appreciation of the other man's job. To this end training opportunities are made available not only to them but to all employees. The objective of this training program is both to train along particular lines, and to broaden one's point of view so that there may be more complete and mutual interchange of ideas and understanding of purpose.

Introductory Courses Orient Recent College Graduates

For those entering the Bell System directly from college, an introductory and orientation course is given by each of the Associated Operating Companies, of which the New England Telephone and Telegraph Company is an example. Likewise the American Telephone and Telegraph Company, in both its Department of Development and Research and its Long Lines Department, the Western Electric Company, and the Bell Telephone Laboratories give introductory courses to college men. These courses are not set up on a standardized basis, but vary from company to company, according to the character of the work performed. In every case there are lectures on technical, organization, and general matters, round-table discussions, field observations, and temporary work assignments. In these assignments, while each student is expected to work on

(*Continued on page 238*)

SECTION OF NEW YORK-CHICAGO TOLL CABLE

The wires in this cable are arranged in groups of four, called quads, and each quad makes available three telephone circuits. In the principal sections of the cable there are nineteen quads of No. 16 copper conductor and 120 quads of No. 19 copper conductor. Development work of this sort offers very great opportunities to the electrical engineer.

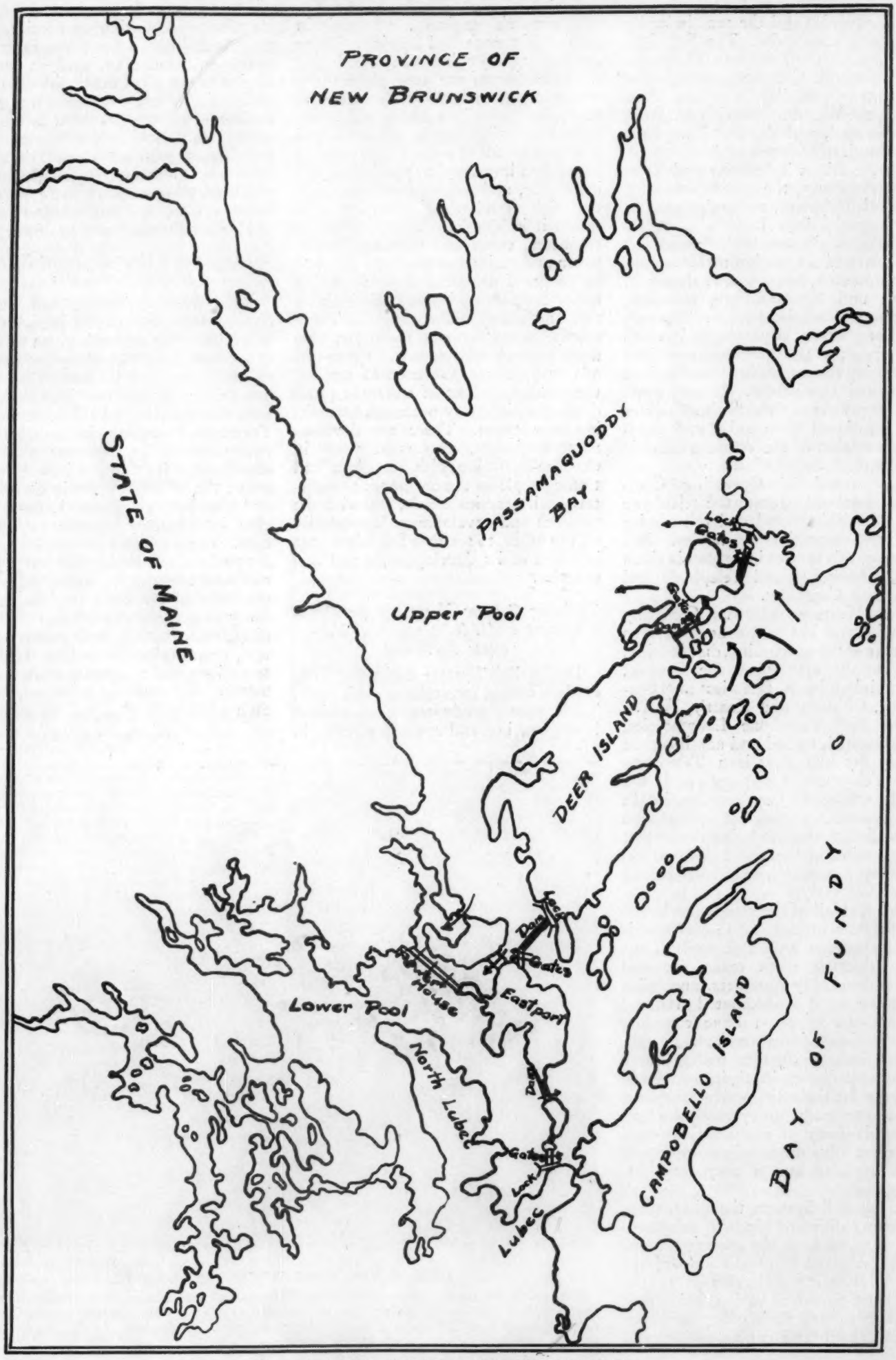

Figure 1. TIDAL POWER DEVELOPMENT AREA

The Passamaquoddy Tidal Power Development

A discussion of the 700,000 horse-power project involving the harnessing of the tides of the Bay of Fundy

By KENNETH C. REYNOLDS

Instructor in Civil Engineering, Massachusetts Institute of Technology.

THE suggested harnessing of the tides at the Bay of Fundy in northeastern United States, as proposed in the Passamaquoddy Tidal Power Project, presents a stupendous undertaking and involves a radical departure from the usual method of developing power in which the flow of a fresh water stream furnishes the necessary energy.

Old charters show that tidal mills were used in England for grinding corn as far back as the eleventh century, while some of more recent date are still in operation. A tidal mill which was built near Davenport, England, in 1790, is even now in operation. The head varies from 14 feet to 9 feet, and the power from the two turbines may amount to 80 horse-power. This wheel, however, can only generate power for 4½ hours at the most. Again, some of the old English wheels depend practically on the tidal current driving a wheel with flat radial paddles and having reversible gears so as to turn the machinery always in the same direction. Naturally, these small, inefficient wheels would not be considered for a modern plant.

About five years ago a tidal plant was proposed in England which called for a dam across the river Severn, affording a continuous supply of energy in excess of one-half million horse-power. The plans for this project required the pumping of large volumes of water into a high-level reservoir so as to make a fall available for those times when the river and sea were at about the same level. Other tidal projects have been proposed for both England and America, but none compares with that being considered for the waters lying between the State of Maine and the Province of New Brunswick.

About two years ago, Dexter P. Cooper first began his studies of the possibilities of constructing a huge power development in which the tides of the Bay of Fundy were to be utilized. Mr. Cooper was born in Minnesota, and has been associated with power projects at Great Falls, Montana, in California, and at Keokuk on the Mississippi.

Mr. Cooper addressed the Massachusetts Institute of Technology Student Chapter of the American Society of Civil Engineers on November 13th of this year, and this article presents a résumé of the information given by him that evening. No attempt will be made to discuss the feasibility of this development. That is entirely outside the scope of this paper. As Mr. Cooper's plans are more fully studied by him as well as by other engineers, the many problems involved will be analyzed, and in time it will be possible to decide whether this project, as outlined, is practicable or not.

The two requisites for a hydro-electric development are a dependable flow and a head of water at the site selected. The former depends in this case on a proper storing of the tidal waters. The head of water is dependent on its being possible for the water to pass from a high-level pool, thence through the turbines, where it gives up its energy, and then on into the low-level pool.

In this project the high-level pool is to be Passamaquoddy Bay, with some 106 square miles of area, while the lower pool is Cobscook Bay, of 46 square miles area. The structure, separating the two pools, would be the power house, which, it is proposed, for the present would be 2500 feet long, although in time it may be doubled in length. This building would house the turbines with the control mechanism, the generators, and the other electrical equipment.

As the map shows, these two pools are practically enclosed by land. Three dams are necessary to close the shore line of the upper bay, two of them being between islands to the north of Deer Island, while the third is from Deer Island to the shore near Eastport. The latter is the only dam which would be difficult of construction. Here the water is 175 feet deep, with a rather high velocity. Mr. Cooper proposes to dump large boulders at this site and gradually build the dam up to the water surface. Smaller stones would be used on the pool side, and then a mixture of clay and gravel, resulting ultimately in a dam which would be water-tight with a 2¾ : 1 slope on the upper pool side and a 1½ : 1 on the other. The lower pool would require two dams between the islands south of Eastport.

All of these dams would be equipped with huge gates so as to regulate the level in each pool. These gates, according to present plans, would be of the mitre leaf type, similar to those used at Gatun Lock in the Panama Canal. The width in the clear would be 100 feet, and the gate would be some 70 feet high, giving an actual water area of about 6300 square feet. Twenty of these gates would be used in the upper pool and ten in the lower. The artificial barriers, including the dams and gates, would total about 14,000 feet in length. Since these waters are all navigable, several locks are proposed. The largest would be on the Deer Island end of the immense dam across to Eastport, and would be 800 feet long, 110 feet wide, and 30 feet deep, while the lock to the north of Deer Island, as well as the one into Cobscook

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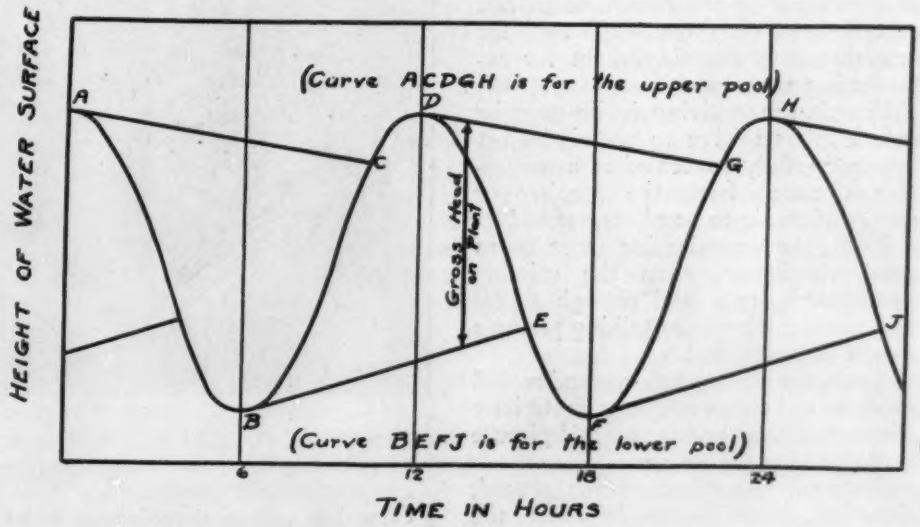

Figure 2

VARIATION IN WATER LEVELS OF TWO POOLS

The curve ABDFH may be considered to represent the rise and fall of the tide. The tide ebbs and flows twice in twenty-four hours.

The Phonofilm

An interesting story of the development of and the principles involved in the talking motion picture as told by the inventor

By LEE DE FOREST

President, De Forest Phonofilms, Inc., New York City.

MY attention was focused on the field of talking motion pictures wholly by photographic recording in 1918. Perhaps the one consideration which, more than any other, prompted me to enter this field was my desire to personally develop a new and useful application of the audion amplifier — one which I could expect to develop largely by my own efforts, as distinguished from its application to long-distance telephony, where obviously the intensive efforts of large corps of engineers, backed by a gigantic business organization, were indispensable. Another motive was my desire to possess a phonographic device which would be free of many of the inherent shortcomings of the disc machine, notably the short length of record, the necessity for frequent changing of needles, and the belief that by means of a pencil of light instead of a steel needle it might be possible to completely escape from the surface scratch which has always been inseparable from the existing types of phonograph.

But at the beginning of my work I laid down several principles, based wholly on commercial considerations, limitations which I considered the talking motion picture must, in order to be commercially successful, fall within. These considerations were:

First, nothing but a single standard cinematograph film could be employed.

Second, the speed must be that of the standard motion-picture film.

Third, the recording and reproducing devices must be absolutely inertialess, excepting possibly the diaphragm for receiving and the diaphragm for reproducing the sound.

Fourth, the receiving device must be sufficiently sensitive to permit its being successfully concealed at a reasonable distance from the speaker or source of music to be photographed.

Fifth, the reproduction must be as good, or better, than the existing phonograph, and loud enough to fill any theater where the talking pictures should be exhibited.

Sixth, the photographic sound record must be so narrow as not to materially cut down the size of the normal picture projected on the screen.

Seventh, the photographic record, therefore, must be one in which the width or amplitude on the film was constant throughout, and the sound variations must therefore be photographed as variations in density in the photographic image. In other words, the light record should be in the form of exceedingly fine lines or parallel bends of varying densities all of the same length, and lying always transverse to the direction of the motion of the film.

To photograph the highest harmonics of any music which it might be desired to record upon a film traveling at normal speed, i.e., twelve to sixteen inches per second, necessitated a slit not more than two thousandths of an inch in width. And in order not to appreciably cut into the size of the picture, the length of this slit must not exceed at most three thirty-seconds of an inch. This in turn necessitated the employment of an intense light source, small enough to go inside the moving-picture camera, and yet one whose intensity could instantly and proportionately be varied by the slightest and fastest sound vibrations which it might be desired to record. Some of the above conditions, it will now be admitted, were by no means easy of realization.

Early in the spring of 1919 I filed patent applications on the methods which I believed would accomplish the above laid-down conditions, and I began actual research on the various means which might be successfully employed. At that time I figured that the work involved should require about two years. The work has been almost uninterrupted, and of the most exacting and discouraging nature. Literally hundreds of experiments have been made, and many thousands of feet of films have been photographed, only to be thrown away.

I well remember the grim satisfaction I felt when, for the first time in reproducing a photographic record of my voice, I was able to determine clearly whether or not it was being run backwards!

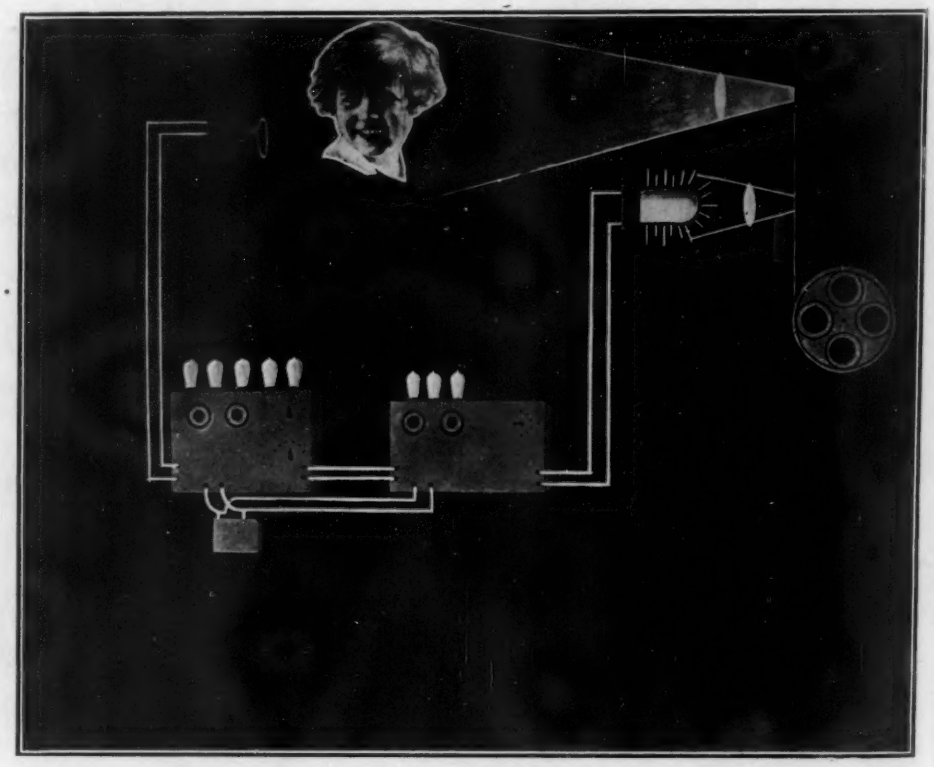

Figure 1

THE RECORDING PROCESS

Chart showing the method of photographing a moving picture and sound waves (music or voice) on the same strip of film. The sound waves are recorded by fine lines on a narrow path along one side of the regular motion picture film. Sound waves are picked up by telephone transmitters, then amplified to radio frequency, thereby controlling the amount of light in the Photion lamp, from which the photographic record is made of the original sound vibrations.

At the start I undertook to photograph the light fluctuations from three different sources. First, that of the speaking flame; second, that from a tiny incandescent lamp filament. To determine whether or not the radiations from these sources were faithfully following the voice, I first exposed the photo-electric cell to their light and listened to the reproduction after it had been many times amplified by the audion in a telephone receiver. I found that both these sources were capable of reproducing voice and music with astonishing fidelity. This was after many refinements in learning how best to apply the voice to fluctuate the flame, and to secure sufficiently rapid cooling of the extremely short incandescent filament to permit the light from the latter to follow the voice frequencies up to three thousand per second. But to my disappointment I then found that to photograph these light variations which were producing such perfect reproduction in the photo-electric cells was an entirely different proposition. A photo-electric cell is far more sensitive than the most rapid photographic emulsion, requiring for translation far less percentage of the variation of the normal light of the source to produce a sufficient change in the electric conductivity of the cell than is necessary to produce for recording corresponding changes in density in the photographic image.

The other of the three methods which I originally set out to develop, although far less simple and more difficult of attainment, proved in the end the practical method for producing by electrical means light fluctuations of sufficient amplitude to be photographed in every necessary degree of intensity.

The light that I employed for this purpose was that of a gas-filled tube excited by high-frequency current. It was not difficult to construct a gas-filled tube giving such a light when excited by a high-frequency current from a small radio telephone transmitter. But it was no easy task to design such a tube which could, when connected to a small five or ten watt high-frequency apparatus, generate a sufficient light to photograph all necessary variations of intensity upon a narrow strip of standard emulsion film, moving at the rate of twelve to sixteen inches per second in front of a slit, one and one-half or two thousandths of an inch wide.

Having now briefly outlined the general principles employed in developing the Phonofilm, a clearer understanding will be obtained if I outline briefly, step by step, the various instrumentalities employed from the original source of sound to its reproduction alongside of the picture upon the silver screen. The photographic charts illustrate quite clearly the various steps involved. First, Fig. 1 is the voice transmitter, designed to transform into electric currents the lightest and the strongest sound waves which may be spoken or played within five to twenty feet from the device. Telephonic currents thus generated are naturally exceedingly weak, and must be amplified through a series of audions to the order of several hundred thousand times their original magnitude in order to effectively modulate the light-generating currents which are being generated in the small oscillator shown on the right. This oscillator is a form of the radio telephone with which you are all more or less familiar. Connected to this high-frequency output circuit is a gas-filled tube which I have called the "Photion." This tube glows at all times with a violet bluish light which is highly actinic in quality. The intensity of this light increases and decreases around its normal brilliance in exact correspondence with the modulated high-frequency energy of the oscillator. The light from the end of this tube is focused by means of a lens upon the very fine slit directly upon the emulsion side of the film. This Photion lamp is placed inside the moving-picture camera at a point where the film is moving continuously some ten inches away from the window of the camera, at which point the motion of the film is, as you all know, intermittent for the purpose of photographing the picture. The combined picture and sound record thus made are, of course, in absolute fixed relation to each other, and there is consequently no problem of synchronization to be solved. It is only necessary that in the projecting apparatus in a moving-picture theater the sound-reproducing device shall be the same distance from the picture aperture, measured in inches along the film, as was the case in the moving-picture camera where the voice and the picture were originally photographed.

The next chart, Fig. 2, shows in the same manner the arrangement used in the projector. Between the upper film magazine and the intermittent, step-by-step mechanism of the standard moving-picture projector machine are located, in two small co-axial metal tubes, the sound-projector lamp and the photo-electric cell. The light from this small lamp is focused, through a

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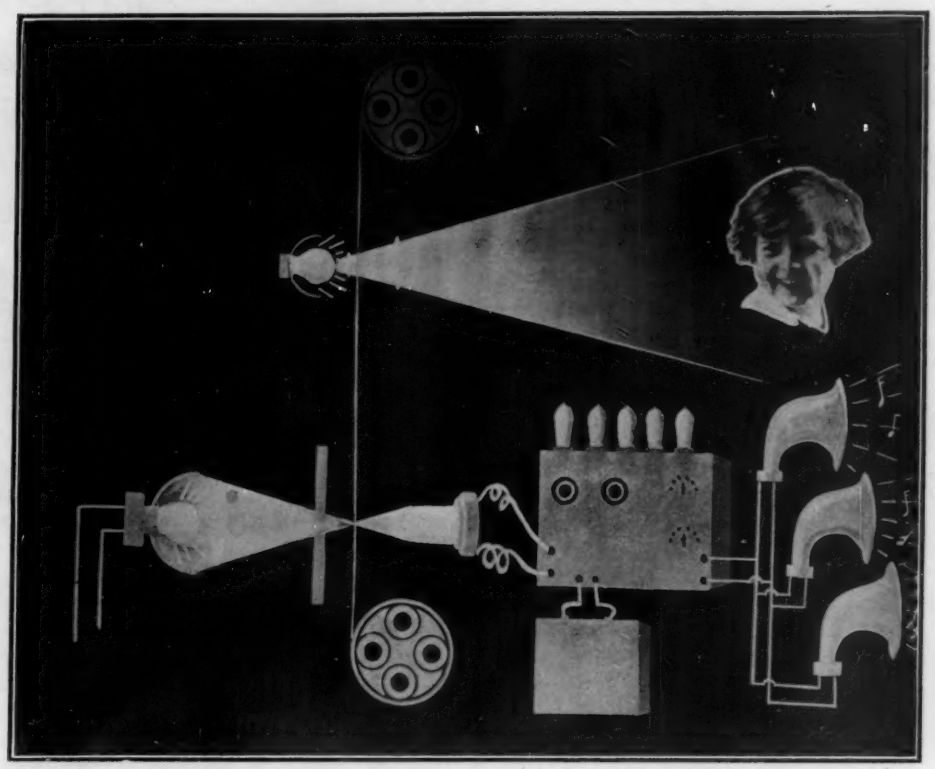


Figure 2

THE REPRODUCING PROCESS

Chart illustrating the method of reproducing the moving picture and sound waves (music or voice) registered on the same moving picture film. Two different parts of the same film aroused simultaneously in the reproducing process of the Phono-film projector, which is an ordinary moving picture projector with a special attachment for the sound record. The keynote of the reproducing process is the use of a photo-electric cell. The fine photographic markings on the edge of the moving picture film where the sound record is recorded control the amount of light thrown upon the photo-electric cell, which thus translates light waves back into electric vibrations, afterward amplified by means of audion lamps and loud speakers.

Aeronautical Developments of 1925

The achievements are less spectacular but more far-reaching than ever before—Air transportation advanced greatly in both traffic and equipment

By EDWARD P. WARNER, '17
Professor of Aeronautical Engineering, Massachusetts Institute of Technology.

THE year just ended will go down in aeronautical history as one in which politics provided more sensations than did technical achievements. The Mitchell trial, the operations of the Court of Inquiry on the Shenandoah accident, and the deliberations of the Select Committee on Aircraft of the House of Representatives and of the special Aircraft Board appointed by the President, have filled the newspapers to the almost complete exclusion of reports of actual accomplishments by actual aircraft.

That is not surprising, for, aside from the wealth of political sensations with which we have been flooded, there has been a comparative dearth of the sort of flying that makes the best news copy. Progress has been by no means lacking, but its manifestation as a whole has not been such as to afford material for headlines.

There have been few new records. The Pulitzer Race, to be sure, brought forth speed higher than any previously attained, but that in itself was a disappointment to the seeker after sensation, for ill-judged publicity, based on a single flight with a diving start and with the wind, had raised popular hopes in anticipation of some fantastic figure. When the previous mark around a closed circuit was beaten by only three per cent, and the record for straightaway speed held in France was not even approached, the results seemed far below the expectations. The altitude record and the American figures for distance and duration stood unchallenged, and although a French machine put up a new world mark for length of flight, there was no such improvement over the best previous performance as to arouse any great excitement among laymen.

From great cross-country trips, as from record-breaking flights around a closed circuit, the year was comparatively free. French pilots made notable "raids," of which the most remarkable was a five-thousand-mile flight around Europe, accomplished in three days, and the American PN-9 attempted a trip to Hawaii, which came to a happy ending after many days of anxious waiting. So far as public interest was concerned, however, the flight around the world was the climax of cross-country achievement, and anything else was doomed to seem tame in comparison.

Notwithstanding these deficiencies and the comparative absence of thrills, 1925 has been by no means lacking in note in aeronautical history. It has been the year in which the use of airplanes for non-military purposes gained appreciation in the United States more rapidly than in any preceding one, the year in which the industry made substantial approach to an adjustment of its relations with the Government and to an opening of other markets which would put it on a sound and stable footing.

It has been characteristically the year of commercial development and of the engineer. Not even in engineering as applied to design has there been any great outstanding achievement, but the entry into production and into service of types designed some years ago has made it possible to estimate by direct comparison the progress resultant from increased aerodynamic knowledge and from improvement in power plants.

The Air Mail's experience furnishes an example. For several years the mail has been flown by modified DH-4's, which in most of their essential details were of 1917 design. A call for the submission of new machines brought out half a dozen, each using the same Liberty engine that drives the old DH-4. Every one of the new types carries a thousand pounds of mail load as against the five hundred pounds, or a little less, of the present Air Mail machine. Every one landed at a speed at least six miles an hour lower than that of the DH-4. Every one came at least within three miles an hour of it in speed, and several of the new machines excelled the old type by five miles an hour or more, and they all outclimbed it handsomely.

That showed what could be done when the power plant remained unchanged. If modern power plants be used, the record becomes still more striking, as in the case of a recent light bombing machine, which, using a single engine of 800 horse-power, and carrying substantially the same useful load as the Martin bombers, now the standard reliance of the Army, has a maximum speed more than twenty per cent in excess of that of the Martin and a ceiling almost twice as high, combined with a somewhat lower landing speed. These things are not accidents. They are the result of painstaking research and experiment carried on without cessation in government, institutional, and private laboratories all over the country, research which has seldom received its proper need of recognition and which has sometimes been collectively damned as a waste of money by self-proclaimed experts who rush in where angels might well fear to tread.

Nowhere has such research been prosecuted more intensively than, if indeed as intensively as, in the United States, and nowhere else have the results been plainer. America is far from having the largest air force in the world, and calamity howlers see imminent threat to our independence in its alleged weakness in numbers. It is reassuring to find, and pleasant to record, that careful investigation of the relative quality of American and foreign service equipment shows that the airplanes which exist in moderate numbers in this country, and which would be available for production in case of need, are excelled by those of no other country and equaled by few. The last five years have been those of development, development which could be carried on the more intensively because war equipment was still usable, and it was therefore unnecessary to lay out great sums of money in purchasing new equipment which would very soon be condemned as "obsolete" in its turn. Within the last year or two the time for beginning definite steps to replace and retire the wartime material has arrived, and definite steps looking in that direction have been taken. Already orders have been placed for ninety observation machines of the most modern and efficient design for the Army Air Service, and the President's Air Board, in its report, laid down recommendations for a continuing policy of replacement at a regular rate, with periodic adoption of new design standards at regular intervals, which should bring encouragement to the builders of aircraft, to whom government contracts have been virtually the sole source of sustenance for most of the last six years.

Of the light plane and glider there is practically nothing to record. The "aerial flivver" seems farther away than a year ago. Except that miniature power plants have increased in reliability, there is no advance to record. As for the glider, that has disappeared, except in France and Germany, and creates very little stir even in those countries. The German technical schools still use the glider as a cheap means of experimenting and trying out their ideas in design and construction, but no other school in an

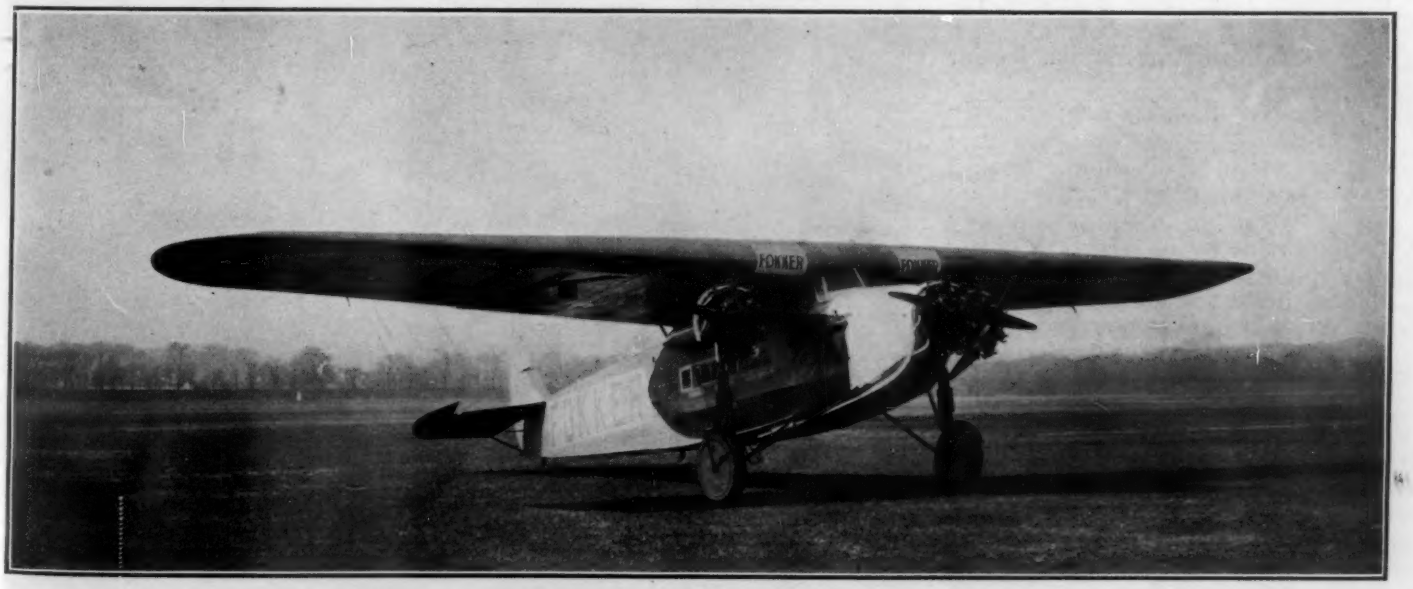
English-speaking country appears to have followed the example set three years ago by the members of the Aeronautical Engineering Society here at the Institute.

The brightest outlook of all is in the direction of commercial utilization of the airplane. Commercial use in Europe has expanded far beyond its previous limits, but it is in America that the greatest progress has been made. A year ago there was no aerial transport in this country other than the government-operated Air Mail, although of course commercial flying for surveying, forest patrol, and other purposes was flourishing. The coming of the new year sees the transcontinental Air Mail re-enforced by an overnight service between New York and Chicago, contracts let for the carriage of mail in privately operated machines on eight or ten routes, capitalists of nation-wide repute entering the aeronautical field with operating companies whose paid-up capital already totals several million dollars, the Ford Motor Company regularly using airplanes operating on a fixed schedule to carry supplies between Detroit and Chicago and Detroit and Cleveland, and several other corporations planning to do likewise. One of the largest companies manufacturing automobile engines has already purchased a machine to carry supplies and officials of the company around among its various plants. The Standard Oil Company of Indiana has now under construction two airplanes designed especially for its service. It seems incredible that so much could be done in so short a time after five years of comparative quiescence. In 1924 air transport operation in America totaled only a little over two million miles of flying. There will be occasion for some surprise if the 1926 figure does not run beyond five million.

Among the brightest indications for the future of transport operation, especially with passengers, is the appearance of the multi-engined airplane, capable of flying, and flying well, with a full load and one engine stopped. Such machines have existed in theory for a number of years, but in practice the full load has had to be kept very light and the operation accordingly uneconomical to get along without one engine. Only during the past season have satisfactory three-engined machines come into regular use. They have been introduced in European practice with such success that the company which holds a monopoly of British air transport has adopted as a policy the gradual elimination from service of all single-engined airplanes, while some of the largest French and German operators are also depending very largely, if not exclusively, on the multi-engined types. In America an impressive demonstration was given in the Ford Reliability Tour by a monoplane of European design but equipped with three American engines, and at least one American transport machine is now being tried with a similar group of power plants. The complete security from forced landings due to mechanical trouble which results from this multiplication of units makes it possible to fly through fog or above the clouds with immunity from one of the gravest hazards that attend such operations now, and makes it safe to strike out boldly with a load of passengers across country where landing fields are entirely lacking and where an engine failure on a single-engined machine would involve a sure crash. The advantages for night flying, also, are too evident to need iteration.

On the European lines, and especially in Central Europe, there has been steady growth, and there is no longer any question about the acceptance of air transport as a normal means of conveyance. During the first six months of 1925, lines under German management carried forty thousand passengers and flew about a million and a half miles. At the same time the British and French companies were transporting from eight hundred to one thousand passengers a week across the English Channel during the height of the tourist season. While much of that activity is artificially stimulated by government support, it is reasonable to expect that we shall see its like in America, even without the necessity of such support given through direct monetary grants.

Nor is the progress of the year confined to air transport. It is manifested in other lines of commercial activity as well. Aerial survey operations continue to extend, and a notable addition to the possible uses of the airplane has been made by the Huff-Daland Company, founded by two M. I. T. men who have started in the South a service for the dusting of crops from the air, with great saving of time and expense to the farmer, and with better protection for the crops, than can be secured in any other way. The private ownership of airplanes is also becoming more common, and several factories have been started in the Middle West to appeal primarily to the private purchaser who wants to fly his own machine.



FOKKER TWELVE-PASSENGER TRANSPORT

This machine is equipped with three motors and is capable of flying with full load on any two of the three motors

Model Basin Theory and Practice

Some theories and practices involved in the operation of the type of basin about to be constructed at the Massachusetts Institute of Technology

By K. E. SCHOENHERR, '22

Assistant Engineer of Tests, Bureau of Construction and Repair, Washington, D. C.

SOME years ago the visitor in Hamburg harbor noticed a brand-new three-funneled ocean greyhound tied up at the wharf in apparent disuse. He asked in surprise, "Why, at this busy season, is this handsome ship idle?" And the answer was, "She made one trip, but ate up more fuel than she could earn." There she lay, her beautiful quarters and spacious decks unused, a liability instead of an asset, because her builders had estimated wrongly, and the speed contracted for on a certain fuel consumption was not reached. Here is the case of a ship worth several millions of dollars being an absolute failure because she fell short of her designed speed. Now, the modern liner runs on a schedule almost as exact as an express train. The arrival in port a few hours behind time may mean that she cannot dock until the next day. Every minute is precious in this time of strenuous competition, and delayed sailings mean losses of thousands of dollars, and may turn a ship from a money-making enterprise to an unprofitable venture.

This tremendous loss might have been prevented had the builders had the modern model basin facilities at their disposal.

The high cost of fuel in recent years has accentuated the problem of propulsion. Leaving out the question of suitable propelling machinery, the problem resolves itself into two parts — the shape of the hull and the efficiency of the propelling agent. Each of these questions so far has defied almost all efforts toward a theoretical solution. Moreover, as we shall see later, the two are not even independent of each other, and in their interaction present new difficulties.

Fortunately there is a comparatively simple remedy, the Law of Similitude or the Law of Comparison. Applied to ships it boils down to this: If we have a ship and its model geometrically similar with a ratio of the linear dimensions of ships to model λ, and the two are towed at "corresponding" speeds, i.e., speeds proportional to the square root of λ, the wave-making resistance is proportional to the cube of λ.

The first practical application of this law to ships was made by the eminent scientist and engineer, Mr. W. Froude of England. Under his direction a model basin was built in 1870 at Torquay, England, in which models of ships were towed, the resistance measured, and the model results used to predict the resistance of the full-sized ships.

Through decades of experience this method has proved to be a most satisfactory one, and today practically every maritime nation possesses one or more of these experimental model basins. At present there are two in the United States, the Navy basin in Washington, and a smaller one at the University of Michigan. The last issue of the *Technology Review* announces that Technology is soon to have a basin of its own which is to have several distinctive features.

The model basin in Washington is 470 feet long, 42 feet wide, and 14 feet deep along the center line. The general arrangement and the carriage which travels over the basin are shown in the accompanying illustration. The carriage is driven by four 50-horse-power electric motors and a speed of 18 knots can be reached. In the center of the carriage the dynamometer and the recording gear are carried. The dynamometer is essentially a balance to the lower arm of which the model is attached.

In making use of the model basin for the design of a ship, the usual procedure is as follows:

The naval architect presents one or several alternative sets of plans for the proposed ship, from which plans, models are made. In Washington the models are 20 feet long and are made of wood, while other basins frequently use paraffin models. The wood models are built up in layers, roughly having the shape of the hull, and are then cut to exact shape by specially designed machines. Finally they are carefully smoothed and varnished. The models are then towed over a range of speed, the maximum speed being slightly above the "corresponding" designed speed of the vessel. At each speed the resistance is measured and plotted on speed as the abscissa. This measured total resistance of the model cannot be expanded directly by the law of comparison to give the resistance of the ship. This is because the total resistance consists of two major parts: wave-making resistance, to which the law of comparison applies directly, and frictional resistance, which follows an entirely different law. The formula for frictional resistance used most widely is:

$F = C\,A\,v^n$ where C is a coefficient varying with the length, A is the actual wetted surface, v is the speed of the ship or model, and n is an exponent variously given between 1.825 and 1.875. Other formulæ of the form $F = AV + B\,v^2$ have been put forward recently as representing more

(*Continued on page 250*)

NAVY MODEL BASIN IN WASHINGTON, D. C.

The basin is 470 feet long, 42 feet wide, and 14 feet deep along the center line. The model is shown in position under the carriage.

The Piece Rate System in Industry

An enumeration of the advantages of the system to employees and employers, including a discussion of the important considerations for success

By GEORGE M. BELCHER, '08
Piece Rate Setting Department, W. H. McElwain Co., Manchester, N. H.

ANY manufacturer or business man will agree that a bargain, to be a good bargain, must be advantageous to both parties concerned. The piece-work plan of wage payment, because it possesses this characteristic, is still the prevailing form of wage payment in nearly all our large manufacturing industries, and is regarded favorably by both manufacturer and employee. The piece-work plan of payment in this instance is intended to include payment plans which remunerate a worker in direct proportion to the amount of work he produces rather than for the amount of time he spends in producing it.

Advantages

The advantage of the manufacturer is obvious. His cost of manufacture, so far as labor is concerned, is fixed at a predetermined figure regardless of any variations in his other operating conditions. Costs, selling-prices, and profits can be figured with a far greater degree of certainty than would be the case if the labor cost were an indeterminate figure dependent on the time spent by the operators in manufacturing the product.

Operating conditions are made easier for the foremen. A wage incentive for increased production keeps the employees attentive to their work with a minimum of time lost in idleness, "fooling," or absence from their place of work. This, too, tends to reduce the manufacturing time and shorten the interval between the receipt of orders and the delivery of goods, an item of vital interest to the manufacturer.

On the worker's part is the satisfaction of working under a simple, clearly defined contract where his compensation is dependent upon his efforts. If he is a more capable man than his neighbor, he has an opportunity to demonstrate this and be rewarded for his extra effort. While this same point is true of other wage-payment plans, such as the differential piece-rate plan, the task and bonus system, etc., the simplicity of a "straight piece rate" is, from the worker's point of view, a point in its favor. Many wage systems, scientifically correct from the standpoint of the industrial engineer, have been strenuously opposed by workers because, as they expressed it, "they didn't know what they were getting." They wanted to be able to compare their rate of compensation with that received by similar workers in other plants of the same industry.

In many industries the piece-work operator has the added advantage of freedom from punching the time clock, to some men a symbol of the "wage slavery" mentioned by radical labor leaders. If by his extra efforts he can complete his allotted day's work before the usual closing time of the factory, it is a source of satisfaction to him to be able to leave the factory ahead of the other operators who must stay the full allotted time in order to receive a full day's pay.

A Connecticut factory once had a gang of twelve men, paid by the hour, who started work each day at 4:00 P. M. and completed their allotted task between midnight and 2:00 o'clock the next morning. After their work had been analyzed by a time-study man, the gang was reduced to eight men, piece rates were established giving the manufacturer a much lower unit cost than before, but allowing the gang ten per cent more pay per man than they had been receiving. Some persuasion was needed to get the men to try the new plan, but after the first night's trial they pronounced piece work a success. They found, as the time-study man had anticipated, that even with the reduced gang they could, by efficient team-work, complete their day's work, earn their day's pay, and still get out on the street before the 11:00 o'clock closing time of the local dispensers of liquid refreshment! [This was in pre-Volstead days.]

Considerations

These mutual advantages to employer and employee are not necessarily typical of every piece-work system. To be successful, three conditions are absolutely essential, and without them piece work of itself may be productive of more strained and unsettled industrial relations than would be the case in the ordinary day-work payment plan. These three essential conditions are:

1. Correct piece rates — accurately determined and mutually satisfactory.
2. Continuous work in sufficient quantity to insure the operator an opportunity to earn a fair day's pay.
3. Provision for instruction and compensation of apprentices.

An accurate determination of the correct piece rate is of course of vital importance. In the past, instances have occurred where piece rates established from production records, foremen's estimates, or plain guess-work have resulted in unexpectedly high earnings. When in these cases the management has arbitrarily reduced the rates, the whole piece-work plan has fallen into disrepute. Operators were discouraged from working to their capacity, and production in the factory was thenceforth slowed down to the point considered safe by the "wise" operators. Such occurrences are far less frequent since the scientific management era developed the stop-watch time study — an accurate method for determining the standard day's production on an operation. The time study itself is of little value, however, if it is not preceded by a careful analytical study of the operation in question for the purpose of standardizing the work steps, the tools and equipment, and the "one best way" of performing the operation. With these elements standardized, the time-study man can determine the standard day's output and the piece rate for it which will return the operator an adequate wage for the work performed.

With the establishment of the price should go also the agreement on the part of the manufacturer that the price remains unchanged, regardless of possible high earnings, so long as the operating conditions remain unchanged; and the agreement on the part of the worker that the price is subject to revision whenever the operating conditions are changed from those outlined in the original time study. This might be through eliminating part of the operation, adding more steps to it, changing the machine speed, providing different equipment, or any similar change which would affect the time of performing the operation. The success of both time-study work and piece-price installation depends largely on the confidence of the employees in the honesty of the manufacturer in his dealings with them on all wage questions of this nature.

The second consideration for the success of a piece-rate system — continuous work in sufficient quantity to insure the employee an opportunity to earn a day's pay — is too often given scant consideration by the employer. It should, however, be looked upon by him as an obligation which he assumes when he hires a man to "work by the piece." It was failure upon the part of the manufacturer to recognize this obligation which led to the "timing out" system of the Lynn shoe workers.

(*Continued on page 254*)

Editorials

"I WANT TO BE HAPPY"

This thought symbolizes the unconscious desire of all of us. Although we seldom think of this, our every act, good and bad, our conformation to existing customs of society, is the result of a subconscious wish for the greatest present or future pleasure.

This is only natural and right. However, it is very easy to get in a rut, and in doing the same work day after day habits are formed that tend to draw us away from our real tendencies.

It is our belief that, unless the student be on his guard against it, a highly technical education, valuable as it is for training the mind, tends toward this very thing — a mental rut. We do not mean by this to imply that there are no men who are not suited best by purely technical studies alone — certainly there are men of this type to whom the sciences are so fascinating that there exists no question in their minds as to their future work.

We are not concerned in this editorial with this class of men, we are appealing rather to those who have no definite idea as yet of the kind of work they wish to enter into when graduation comes.

Everybody knows that there are many men in college who have drifted into their courses with practically no knowledge of what their courses lead to.

The second year at the Institute is the stage where one should begin to have some sort of crystallized idea of the branch of engineering he is best fitted for. It is very important that the freshman realize this, for selection of a course for the next three years must be made at that time, carrying with it, as it does, a great influence on his future life-work.

It is so easy in the freshman year to get in a rut, and when the time comes for final selection of a course, to sign up for the same one regardless of possible far greater capabilities in other directions.

There is one sure preventive of this thing — that is, participation in activities. This is hammered at every incoming freshman, but most fail to realize that the real benefit from activities does not come from the honor of a managership, or of being a star athlete, so much as from constant association with men of high calibre and of broad viewpoints. The candidate forgets his studies for the moment, and finds that he is learning something even more valuable — the art of associating with his fellows on a basis of good sportsmanship. He makes friends of the highest type and learns how to hold them. The athlete finds that he is able to hold his own physically as well as mentally, and this gives to him a kind of quiet confidence in himself that can be gotten in no other way.

The man in activities does so many things, he meets so many men, absorbing their different points of view, that his mental outlook is broadened as the pure scholar's never is. When the time comes to select his branch of engineering training, he is ready, he knows his capabilities, his business, social, and scholastic ability, and is able to judge with a clear mind the thing to do that will bring to him the greatest future happiness.

ISOLATION VS. T. E. N.

Western civilization becomes more specialized every day. The trend is always toward more innate subdivision of labor, physical and mental. Mass production sets the worker before a machine to pull levers at stated intervals. In a different way, limits have been set to the work of the designer. So great is the store of information that has been collected in the few years of industrial expansion that the average man cannot hope to cover more than a small section of his chosen field. Even the sphere of the executive has very definite bounds.

It is not easy to see what will be the outcome of this process. In former times it was said that the engineer had no knowledge and no interests apart from applied science. If the habit of mind of the engineering student may be taken as suggestive of the probable trend of engineering thought in the near future, an even more severe indictment may become necessary. There is a danger that concentration on one particular line of effort will result in an increasing indifference toward other branches of the profession. How many men at Technology take much interest in courses other than those in which they are enrolled? It is right that the latter should be the chief concern. There is little time to get far below the surface of more than one course while at the Institute, and so other subjects taken must consist largely of heavy preparatory work. There are other sources of information, however, which may be tapped with little mental effort. One of the chief purposes for which T. E. N. was founded was that it might do something toward filling this very need. T. E. N. is not a large publication. We hope that each issue may supply articles on topics of engineering and scientific interest so presented as to be at the same time instructive and readable, supplemented in the news columns by a survey of current engineering events. In the case of those readers with the will and the time to go farther, our purpose is to awaken interest and perhaps suggest the most fruitful fields of information. Almost every branch of engineering work is represented by one or more periodicals. These are to be found in Technology's libraries. The great majority of students will have no such mass of interesting matter readily available after they graduate, and yet in the central library in its most crowded moments one sees perhaps a hundred men, chiefly engaged in studying their own text-books. Certain journals which deal with one or two branches of engineering having a particularly popular appeal seem to be fairly widely read. The more general engineering magazines largely remain on the shelves — sufficient indication of the prevailing lack of interest.

Specialization should not mean isolation. We venture to say that a wide interest in the whole field of engineering, and far beyond it if possible, will make a man more efficient at his own particular work and infinitely better able to correlate it with that of others.

PROGRESS

There is a movement afoot among civil engineers in this country which has for its object the raising of the present values of allowable working stresses in structural material. The desire for such a change, moreover, is not confined to this side of the Atlantic, for a very similar wish is expressed in a presidential address delivered recently to one of the civil engineering societies of England.

This is a question on which every civil engineer of experience must have an opinion, and not only civil engineers, but all those of other branches who have to do with the strength of materials.

The *Engineering News-Record* points out that those opposing any change use the argument, among others, that high factors of safety furnish additional protection against incompetence in design. This is characterized as "false doctrine" on the ground that the men who fail in this respect are "quacks" and not engineers. The British address treated also of construction. In substance, the question was asked, "If we are to be protected against bad workmanship why pay for good workmanship?" The speaker further stated that this must not be taken to mean that he was in favor of bad workmanship, but that, as bad workmanship certainly should not be tolerated in construction, it should not be allowed for in design.

(*Continued on page 240*)

Recent Books

This department conducted in co-operation with the Technology Library

Materials Testing Theory and Practice. By I. H. Cowdrey and R. G. Adams. New York: John Wiley & Sons, 1925. 129 pp.

This book has been written as a text for the course in Testing Materials Laboratory at the Massachusetts Institute of Technology. Assignments in it are to cover ground formerly given by verbal instruction, thus saving time in class for observation of materials under stress. The student taking Testing Materials Laboratory has already had as preparation courses in Applied Mechanics and Materials.

The authors have done a good job, having evolved a compact book cut down to absolute essentials. Three general subjects are discussed: the testing machine and its appurtenances, methods of testing the material in question, and the behavior of the material under stress. The book is illustrated, well indexed, and well arranged. One questions only the placing at opposite ends of the book of the chapters on "Testing Machines" and "Verification of Testing Machines."

It is probable that many other engineering schools can use this text to advantage. One can prophesy that those desiring changes will ask for more pages. Somebody will lament the exclusion of a laboratory syllabus and someone will call for the inclusion of more information on materials, both of which the authors had no desire to do for their course.

If the student does his part, there is no reason why the T. M. Lab instructor should not be a much more silent person than in the past, while book and specimen speak for him.

DEAN PEABODY, JR.

Coal: Economic Problems of the Mining, Marketing, and Consumption of Anthracite and Soft Coal in the United States. By Edward T. Devine. Bloomington, Ill.: Amer. Review Service Press, 1925. 448 pp.

Dr. Devine was a member of the United States Coal Commission of 1922-23, the so-called "fact-finding commission." That Commission made a diagnosis of the evils of present methods in the coal industry, inquiring impartially into the interests of minors, operators, dealers, and consumers. From the great mass of facts assembled by the Commission, Dr. Devine has selected such as seem to him to bear most directly on a national policy. "At present," he states, "we have no national policy except one of drift." His conclusion is that the only remedy for present conditions is the substitution of a get-together policy for the present chronic belligerency between operators and miners. To show that such a policy is practicable, he devotes over one hundred pages of the book to showing what concrete steps thereto can be taken by owners, operators, miners, railroads, the government, consumers, and others.

America's Greatest Garden: the Arnold Arboretum. By E. H. Wilson. Boston: The Stratford Co., 1925. 123 pp.

Somewhat outside the range of books ordinarily reviewed on this page, this volume is none the less one that should command the interest of many Tech students. Those who have at least once during their stay here visited the Arboretum, and those who still plan to make the trip, will alike find the book most helpful to a better understanding of the rare sights to be seen within the Arboretum walls. In its chosen field, the cultivation and study of the world's hardy trees and shrubs, the Arboretum is said to be without a peer the world over. Numerous photographs of trees in bloom lend charm to the book and enhance one's desire to visit or re-visit this greatest of tree-and-shrub gardens.

Chemistry and Civilization. By Allerton S. Cushman. New York: E. P. Dutton & Co., 1925. 171 pp.

Chemistry in the service of man is the author's theme in this volume founded upon the series of lectures delivered by him at the Wagner Institute of Science, Philadelphia, under the Richard B. Westbrook Lectureship Foundation. In excusing the work, the author explains that other writers have not been at such pains to link up the present and future of this branch of science with its historical past.

He here endeavors to make the reader realize and appreciate what science has done in helping to build up our present civilization, and fully explains the significance of the contributions to chemical knowledge made by the early investigators, beginning with the alchemists, and continuing through the distinguished line of chemists, Priestly, Cavendish, Davy, Faraday, Lielig, and Pasteur.

In the chapter on Chemistry and Industry, Dr. Cushman, himself a most distinguished industrial chemist, gives the interesting stories of the more important chemical industries — soda, sulphur, iron and steel, ceramics, cement, coal tar dyes, and stresses the fundamental importance of chemical science to human development.

A most interesting and enlightening chapter is devoted to the subject Chemistry and War. The author shows the power of the chemist in waging war through the fixation of nitrogen for supplying food crops and producing death-dealing explosives, the fabrication of poisonous gases, and the development of protective devices against the same. The problem of securing a sufficient supply of nitrates and potash in our own country, and its relation to the country as a whole, is discussed. The author believes that the United States is not as far advanced in this respect as some of the other nations simply because American capital has never properly supported the chemists of America.

This revised edition contains an entirely new chapter on Modern Concepts of Matter and Energy. Basing the discussion on the atomic constitution of matter, first announced by Democritus, the Greek philosopher, four hundred years before Christ, the author gives a popular exposition of the astronomy of the atom. In a short discussion of isotopes, he asserts that the transmutation from mercury to gold, the dream of the early alchemists, is possible, and that modern alchemy has won its way to respectability.

The volume, while written essentially for the layman, is of particular interest to the scientist. Students at the Institute, striving now to make themselves pre-eminent in the fields of research and industry, will find this book suggestive, inspiring, and interesting.

Office Management: Principles and Practice. By W. H. Leffingwell. Chicago: A. W. Shaw Co., 1925. 850 pp.

Seven years ago Mr. Leffingwell published his "Scientific Office Management," which dealt with the mechanical application of the principles of scientific management to the office. It was concerned mainly with results.

The present book presents systematically the fundamental scientific principles which the author believes should underlie all office procedure. Ready-made plans and systems are avoided, in the belief that original thought should be encouraged. With its 850 pages, the work is almost an encyclopedia of office management — with emphasis always, however, on principles rather than on detail of method.

Photo-electricity. The liberation of electrons by light; with chapters on fluorescence and phosphorescence, photochemical actions, and photography. By H. Stanley Allen. London: Longmans, 1925. 320 pp.

The second edition of a scientific book first published more than a decade ago must inevitably contain considerable new material, if not a complete reorganization of the original content. This second edition of Dr. Allen's "Photo-electricity", however, has not suffered so complete reorganization as might have been expected, due largely to the fact (as stated by the author in the preface) that "the facts of photo-electricity recorded in 1913, and the deductions drawn from them, remain substantially true today." Notwithstanding this statement, many recent developments have been described, and an extensive bibliography (pp. 287-311) covers references to scientific papers relating to photo-electricity published from 1913 to 1924.

Perhaps the most important feature of the new edition to the student engineer is the chapter on the development of the photo-electric cell and its applications. This is a valuable compilation of the data obtained by numerous experimenters.

Plentiful foot-note references throughout the text make the book a thorough foundation for the detailed study of photo-electricity, and the fact that it is one of the "Monographs on Physics," edited by Sir J. J. Thomson, at once gives it the recommendation of high authority.

America's Greatest Dam, Muscle Shoals, Alabama. By Wm. Benjamin West. New York: Frank E. Cooper, 1915. 64 pp. Second Edition, revised.

In view of the splendid tributes and hearty approval the first edition met with from the general public, the book has been re-written, enlarged as to text and illustrations, and brought up to date. The work, which is now profusely illustrated, describes in detail the Wilson Dam, which has been constructed at Muscle Shoals, Nitrate Plant No. 2, Alabama. There is included a concise description of the process for manufacturing ammonium nitrate by the cyanamia process, as well as some remarks on Common Sense in Nitrate Production, occasioned by an article by Dr. F. G. Cottrell, Director of the Fixed Nitrogen Research Laboratory of the United States Department of Agriculture, appearing in THE TECH ENGINEERING NEWS.

The book, although written primarily for the layman, is of interest to the technically inclined, and is well worth the consideration of the student.

Principles of Electric Power Transmission and Distribution. By L. F. Woodruff. New York: Wiley, 1925. 340 pp.

The evolution of a text-book from notes tried, tested, and found good by an instructor in his class-room work for several years is a sufficient guarantee of its merit. Such a book is this one just published by Mr. L. F. Woodruff of the Electrical Engineering Department.

The fundamental scientific principles of electric power transmission are brought together with a considerable amount of information on present-day practice. To physical theory is added mathematical interpretation, and the three appendices contain an unusually valuable compilation of tables and mathematical data for problem solution. Not one of the book's 340 pages is extraneous to the matter in hand. Mr. Woodruff has made a contribution to the literature of electrical engineering for which there has been a long-felt want.

The Engineering Field

Excerpts from the leading professional and trade Journals

Electroplating Rubber. It has been found possible to plate rubber, which is known as an excellent insulator, electrically from a colloidal solution onto either metal, wood, or cloth. The process is of recognized importance to a large part of the rubber industry, as it will make possible, for instance, the coating of cloth garments already made up, with rubber to produce a "seamless" garment.

The process depends on the fact that rubber latex in colloidal solution becomes negatively charged when a little ammonia is added, and will readily plate out under the influence of an electric current. The important feature of the action is that the colloidal particles of latex readily absorb impurities into their enveloping albuminous sac and carry those impurities with them when plated out of solution. If the substances which are usually mixed or milled into the rubber to make vulcanizing possible are added to the colloidal solution in correct proportion, then the rubber plated out will be all ready to be vulcanized. No further treatment is necessary.

The ordinary mixing or milling process, which tends to weaken the rubber, is eliminated, while the necessary ingredients are much more thoroughly mixed in with the rubber itself.

The current voltage may be as high as 100, while the amperage may vary from .002 to 1 ampere per square inch of surface being covered. The rubber has great "throwing powers," i.e., it plates out very evenly over a large surface. A help in solution of the scrap rubber problem is seen here. The scrap may be mixed with a solvent, emulsified with water, then finely ground to make an emulsion which behaves in the same way as the fresh latex emulsion.—*Scientific American.*

Strain in Concrete measured by a new method. Some time ago, the Bureau of Standards brought out what is known as an electric telemeter for measuring changes in the length of structural members produced by variations in the load upon the structure. The operation of the telemeter depends upon the variations in resistance of a stack of carbon discs to the passage of an electric current. This is the same principle as that employed in the microphone in the transmitter. This principle, therefore, is not new, but was here first applied to a precision measuring instrument.

Recently a new use has been found for this device in the measurement of the strains in mass concrete. For this purpose, a special cartridge has been designed to house the stack of carbon discs which is embedded in the concrete at the point where the measurement is to be made. Wire leads extend to the surface and are carried to some convenient point where the indicating instruments are placed. These instruments are calibrated to show any deformation in the concrete due to loading.

The instrument will shortly be used in an investigation which is to be carried out by a special committee on a dam to be erected at Fresno, Cal.—*Engineering and Engineering.*

The Aeromarine Starter is a hand starter in which the cranking energy of the operator is not applied directly to turning over the engine crankshaft, but instead is used to start a flywheel rotating and bring it to a speed of over 1600 r.p.m. by means of a crank and gears. Although the flywheel is very small and light, the rotative speed is tremendous. When it is remembered that the energy stored is dependent on the square of the velocity, it is easy to account for the fact that the small wheel delivers an enormous torque moment through the gears back to the motor crankshaft. When sufficient energy has been stored by the flywheel, the operator pulls a control rod which connects the starter to the engine. This diverts the accumulated energy through a train of gears into turning over the engine crankshaft. The weight of the new starter, the flywheel of which weighs 5 pounds and is 5 inches in diameter, is about the same as that of the lightest electric starter without the storage battery. The chief advantages of this device are that it has a high initial cranking speed, and the operator is free from all possibility of injury. Furthermore, possibility of damage to the engine is prevented by the use of an overload releasing clutch.—*Aviation.*

Ductile Thorium. As a result of a search by chemists over a period of one hundred years over all the world, a new metal of immediate value and vast possibilities has been added to the world's technical resources in the form of pure metallic thorium. The thorium has a hardness about that of soft iron, but it is fifty per cent heavier. Its melting-point is higher than that of platinum. It is easily machined and can be worked cold.

The uses now are chiefly in radio and X-ray tubes, but new uses are being developed by research. Thorium passes off electrons at a very rapid rate. Instead of an admixture of thorium oxide in a tungsten wire as used in the present radio tube filament, a thorium wire will be used, very materially increasing the tube efficiency.

In X-ray work it will replace tungsten as a target material. The higher the atomic weight of the target material the more powerful and more penetrating the rays. Thorium will give about twenty-five per cent better results than tungsten, for its atomic weight is 232 compared to tungsten's 184.

An Internal Combustion Boiler. Recently an English firm has taken out patents for an internal combustion boiler. Briefly, the proposal is to burn the fuel under high pressure and to mix the products of combustion with a certain proportion of water which is vaporized by the heat of combustion. This mixture of steam and non-condensible products of combustion is first utilized in an engine in which it is expanded down to a certain back pressure. At this pressure the mixture is exhausted into a low-pressure boiler, the pressure in which is such that the temperature is below the condensation temperature of the mixture. The steam in the mixture is condensed and discharged as water. The heat in this water may be thrown away or used in any manner desirable. The non-condensible gases are taken to another engine or to a tandem cylinder of the first engine, expanded further, and then exhausted into the atmosphere.—*Engineering and Boiler House Review.*

Fog Exhibits Refraction In Striking Manner. Dense fog has the peculiar property of reducing or destroying audibility within certain zones. Marine disasters along coasts are sometimes due to the fact that sound signals which are plainly audible during clear weather cannot be heard within certain zones of silence when the sounding object is surrounded by dense fog. A recent example is that of the steamer *Siberian Prince*, which went on the rocks at Bentinck Island during a dense fog while the fog signal at Race Rocks near by was in operation. Subsequent investigation revealed the fact that the sound of the signal could be heard at this point in clear weather, but not during a dense fog.—*Tycos.*

Full-Size Test Dam Under Construction. The design of arch dams is based on theories for which there has been no experimental confirmation. In using a unit stress for concrete which has an ultimate crushing strength in excess of 2500 pounds per square inch, varying from 250 to 350 pounds, dams have been built which may be much too thick, hence too expensive, or dangerously near the limit of safety in thinness. In order to get the reliable information needed, a sixty-foot arch dam is being built for test purposes — test to destruction if possible — on Stevenson Creek, near Fresno, Calif.

A small gorge with steep granite walls affords a suitable site with small reservoir capacity. The dam will be of the single arch type. Its upstream face will be vertical with a constant radius of 100 feet, and its upstream profile of V shape, slightly rounded at the bottom. The dam will be built to a height of 60 feet and tested repeatedly for a year under varying load and temperature conditions. In case it does not fail at this height, it may be extended in ten-foot steps to 100 feet height.

The high class of engineers in charge, and the institutions co-operating, insure a most complete and accurate set of data, including data from models of other types of dams, on which reliable conclusions may be based.

New Generator for Ultra Short Waves. Two years ago, Nichols and Tear succeeded in producing waves as short as .22 mm. by use of two short electrodes which were connected to a source of high-voltage electricity. When a spark was allowed to pass between the two short rods, oscillations were set up, in the same way that they are produced with the regulation inductance and condensers, except that in this case the inductance consisted of the length of the two rods, while the capacity was simply the distributed capacity existing between them.

A Russian physicist, Madam A. Glagolewa-Arkadiewa, has gone a step further along the same line, and has succeeded in producing waves of only .082 mm.

The work of these two pioneers has connected the wave spectrum through one of the gaps which used to be marked "unknown" in the old physics and chemistry books, the old gap between radio waves and heat.

As described by *Popular Radio*, the new generator consists of iron filings made to oscillate electrically in a rather novel manner.

The filings are suspended in oil, which is kept stirred mechanically so that the filings will not settle. Into the mixture of oil and iron filings, there dips a slowly rotating wheel, so that a layer of the oil-filings mixture is carried up on the edge of the wheel, like mud on a wagon tire. Two leads from an induction coil dip into this rim of filings on the wheel. The discharge occurs through the oil-filings mass, so that each tiny bit of iron oscillates alone, and collectively the effect of course would be to increase the intensity of the emitted waves.

The wavelength of the emitted rays would of necessity be very broad, for each of the filings differs from the other, and would depend on the size of the filings.

Boiler Scale has heretofore been removed only by mechanical means, but recent experiments in England show the possibilities of the use of a solution of carbon dioxide in water as a solvent for boiler scale.

Preliminary tests on fragments of boiler scale were made by placing them in a bottle, covering them with water, and then charging the water with carbon dioxide at a pressure of seventy pounds per square inch. After a few days, marked disintegration of the scale was apparent.

Large scale experiments were made on tubular boilers supplied with water which was high in silica and lime and low in carbonate, and in which the scale had been allowed to accumulate for years. Ordinary methods of removal had failed. Carbon dioxide was charged into the boiler through the circulating pump, and the temperature of the water kept at 84° F. The boiler was allowed to stand for eight days, after which it was opened, the softened scale being knocked off with a high-pressure hose. Half the surface of the boiler was left entirely free from scale and rust, and the clean surface had the color of new metal.— *Chemical Age* (*London*).

SITE OF STEVENSON CREEK PROJECT

A large 60-foot dam is to be built here solely for purposes of tests, to end in its destruction. Sketch shows preliminary work that has been done on dam.

Aerated Concrete. In the housing section of the Wembley exhibition, there was shown a cottage constructed of aerated concrete, which may be described as a cellular concrete of sufficient strength for structural purposes and general repair work. The principal constituents are cement, "chemical crystals," and water. After the ingredients have been mixed, a chemical action takes place. Hydrogen is generated and forms little bubbles in the mass, depending on the properties of crystals. The initial set of the concrete takes place before the hydrogen is driven off by the air pressure. The material is light in weight — a brick of it will float in water for seven hours and show no signs of sinking. Yet the strength under compression is up to about 500 pounds per square inch.

The Highest Temperature yet produced by man has been reached at the University of Leeds, England, by the combustion of ordinary manufactured gas combined with oxygen. A temperature of 7677° F. or 4287° C. was attained.

Here and There

Interesting notes from the Editor's desk

DON'T BE A DRIFTER

There are many drifters in this world going with the current wherever it may happen to carry them. They stick to a job simply because it is easy, and if it becomes hard they leave it and go on their way, looking for some other job that is soft.

Honestly, deep down in their hearts, they intend some day to do something big, but they live only in yesterday and tomorrow. Today, alive with opportunity, has no meaning for them.

The way of the drifters is always down stream, so that opportunity is always moving away from them.

Unless you know where you are going, and are really rowing as hard as you can to that point, you are drifting.

Unless you are willing to accept responsibility and really work, you are drifting.

Unless you can actually see each day's work moving you ahead in force, strength, and efficiency, you are drifting.

The drifter always goes down — never up. And he finally either goes over the falls of failure or lands in some pool of mediocrity where he remains all the rest of his life.

Don't be a drifter!

Ambition doesn't mean thinking wonderful dreams, while you float with the tide.

It means taking off your coat, rolling up your sleeves, and pulling your boat upstream.—*Excerpt from "Aera," September, 1925.*

THE EXPERIENCE OF BEING STRUCK BY LIGHTNING

It has fallen to the lot of relatively few of us to have as dangerous and as interesting an adventure as happened recently to M. S. MacQueen, of the University of Wisconsin, who was struck by lightning while crossing an open lot used by the University for the storage of coal, and who lived to tell of his experience. A companion, W. E. Armentrout, was struck at the same time and instantly killed.

Mr. Eric R. Miller, of the Weather Bureau Office at Madison, tells of the experience.

"He was conscious throughout the period of the electrical discharge and realized that he was being struck by lightning. He says that the pain of the spasmodic contractions of his muscles was terrible, but the noise and heat of the flash were nearly as bad. He speaks also of a sensation of terrible pressure on his head. The current entered his body at his left shoulder, which is seared over an area of about four inches. The muscles of his legs near the ankles were wrenched by the spasmodic contractions, and were swelled so that his leg at that point was about twice normal size when I saw him. He was paralyzed from the waist down for a few hours after the flash. Armentrout, who was killed, was also burned on his left shoulder and arm, and a small patch of hair was burned from his head. MacQueen, who fell beside his friend, tried to rouse him, and noticed that as he did so the body turned blue. This was an indication that the lightning had stopped the heart action instantly, probably as a result of severe tetanus due to the passage of electricity through the muscles of the heart."

Three holes remain to show where the lightning entered the ground.

That iron has little directive effect on lightning was shown by the fact that a railroad rail lay about ten feet away, the tracks of a railway switch about thirty feet away, and a crane a hundred feet distant. The cloud which contained the death-dealing charge came from the southwest, had passed over houses, trees, and an iron smoke-stack within a few hundred yards.—*Safety Magazine.*

The Periodical Division of the Library of Congress has informed the Editor that the following issues of THE TECH ENGINEERING NEWS *are needed to complete its file:*

Vol. III, No. 9, March, 1923
Vol. IV, No. 1, April, 1924
Vol. IV, No. 8, March, 1925
Vol. VI, No. 1, April, 1925

This notice has been inserted with the hope that the possessors of any of these desired issues will inform the Editor of their possession.

CLEVELAND, OHIO, OFFICIALLY ADOPTS RADIO-EQUIPPED CARS

Let the Cleveland evil-doers beware, for the Black Maria will appear on the streets oftener than of yore.

Jacob Graul, Chief of Police, following a test of the efficiency of radio receiving on his private police car, has become converted to the belief that radio equipment on Cleveland's police cars will be a great aid in the capture of criminals. As a result, seven other cars of the "flying squadron" are being equipped with similar apparatus.

The Cleveland Police Department has eight 70-h.p. Peerless cars for squadron work. Each of these cars will carry one receiving set, two head sets, and a loud speaker.

The central transmitting station will be located at headquarters and will send the orders to the flying squads at the precincts or on the road.

The transmitter is being licensed for a low wavelength, presumably about thirty or thirty-five meters, to preclude possibility of outside interference, and to eliminate to a great degree the likelihood of any irresponsible outsiders getting information, as the construction of a receiver for this range necessitates considerable special knowledge that the criminal element would not have.

Tests of the police equipment showed it possible to hear clearly when the car traveled at a speed of fifty-four miles an hour.

"SCIENTISTS," WEARYING OF VITAMINES, NOW PICK ON TEA

In the advertising columns of our favorite rag, we may yet see testimonials published by the customers of the great tea companies alongside the space accorded to Lydia E. Pinkham's gift to mankind—pardon us!—women.

First it is MacMillan, the Arctic explorer, who shouts for tea and endorses the benefits derived from the stimulant on the long, hard marches over the drifted snow and ice of the Far North.

Then it is Yale's 1925 football squad, who this year included tea in their training diet. The team, according to an A. P. dispatch from New Haven, indulged in the beverage between halves, with splendid results.

Thirdly, but not least, comes an announcement from the University of California that a new vitamine, extracted from tea, has been discovered, for which it is predicted that its use will result in an increase in the span of human life. This vitamine has been named "bios," and it is said to be the most valuable of any of the vitamines that have yet been discovered.

We hope that this report of the new vitamine does not exaggerate matters, for, to tell the truth, we would not be averse to an extra ten or twenty years, providing we could spend them in "Back Bay," Boston.

HEIDELBERG STUDENTS BAN RABBIT STEWS

Thieves broke into one of the medical laboratories of Heidelberg University and stole some inoculated rabbits. Stewed rabbit was formerly a very popular dish with the students, but is now utterly banned, and the police are instructed to shoot any rabbit seen at large.—*Scientific American.*

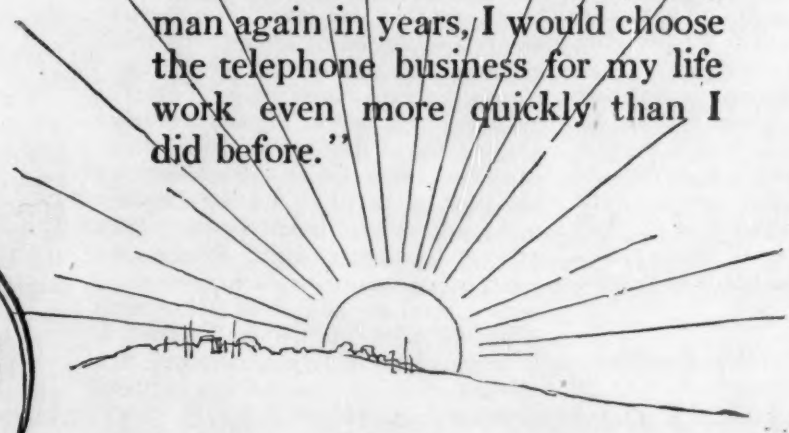
"Our pioneering work has just begun"

RECENTLY some one said to a prominent official of the Bell System:

"Your pioneering work is done. You have created a system that makes a neighborhood of the nation."

The executive replied:

"Our pioneering work has just begun. Each day brings new problems, new discoveries, new developments, all calling for broader-visioned handling on a larger scale than ever before. If I were a young man again in years, I would choose the telephone business for my life work even more quickly than I did before."



Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

Published for the Communication Industry by

Western Electric Company

Makers of the Nation's Telephones

Number 54 of a series

Training the Electrical Engineer

(*Continued from page 223*)

much the same basis as an older employee, he is given the opportunity to learn from actual contact the interpretation of theory into the various aspects of every-day practice. The supervisors in charge are asked not only to assign them actual duties, but see that opportunity is given to advance to more difficult tasks from week to week. The objective is to observe, ask questions, have one's interest and curiosity aroused, and get first-hand experience in the technique of the work. On many occasions old clothes are donned and a hand is given in the manual operations going on.

One of the companies follows the plan of giving work assignments ranging from four to six weeks interspersed by a week of lectures and round-table discussions. This program is followed for six to eight months before the question of definite work assignment is discussed with the man.

In the large Hawthorne factory of the Western Electric Company the same general scheme is followed, although in this case the lectures, discussions, and work assignments center around manufacturing methods and special machinery for making telephone apparatus. The Long Lines Department and the Department of Development and Research of the American Telephone and Telegraph Company arrange their courses to supplement the graduates' college training and to bring out its applications to the telephone business.

At the Bell Telephone Laboratories the new engineer is given a brief acquaintance with each of the several departments, the physical layout of the laboratories, a brief survey of the work going on, explanation of routines for handling the job day by day, and frequent talks by the heads of departments.

Other Courses Available to Qualified Employees

After one or more years of service, engineers are selected for advanced training. This brings repeated opportunities to acquire both a fuller knowledge of the details of their own fields and the broader phases of related branches of the work.

As an example of "training in service" for men of supervisory grade, the transmission school and the inductive interference school conducted by the American Telephone and Telegraph Company in New York are typical. To these schools the Associated Operating Companies have sent their representatives. For three months during 1920 and 1921, 90 men from 15 different telephone companies studied thoroughly the fundamentals and recent developments of telephone transmission problems. Again, in 1923 and 1924, some of these same men were included in the many who came to New York for study of the problems of electrical inductive effects between power and telephone circuits. Sixteen companies were represented by 132 men who studied the fundamentals and new developments in inductive interference, crosstalk, and the relation between telephone and power circuits. Specialists in these subjects acted as instructors, giving lectures, problems, laboratory work, and holding round-table discussions.

Having finished a course such as this, each engineer takes back to his own organization an understanding of the newest phases of its work. Through daily contacts he now shares both enthusiasm and information, and frequently acts as instructor in a school attended by men selected from the outlying divisions of the company.

Aside from courses of a specific and technical character, some of the Associated Operating Companies give from time to time a set of twenty-five to forty general lectures covering the basic and fundamental aspects of the telephone business. Members of the accounting, commercial, engineering, plant, traffic, and executive departments are invited to attend. By such lectures the commercial department members learn something of traffic matters, and traffic department employees are advised as to the methods whereby transmission problems are handled by the Engineering Department, and so on. In one company each of forty lectures, covering sixteen subjects, was given twice during one year, with a total attendance of 4045. Such a group, with mutual understanding of each other's jobs, contributes much toward effective co-operation between departments.

To those employees whose work lies along commercial engineering lines, instruction is given in the following subjects: principles governing the making of telephone rates, cost studies for rate purposes, telephone directory listing practice as related to directory cost, population estimates, budgets, budgetary control through provisional estimates and commercial surveys.

The Bell Telephone Laboratories in New York City have for a number of years given valuable training courses, some for high-school graduates, and many others of a scope equal to those given in university graduate schools. Instructors are regular members of the technical staff, consisting of about 2000 highly trained scientists, engineers, and assistants. Differential equations, modern physical theories, theories of speech and audition, and telephone apparatus design are among the courses given out of work hours and attended by an average of 1200 men per year.

For many years the manufacturing plant of the Western Electric Company at Hawthorne Works, Chicago, has given training courses subsequent to those taken upon entering. The widely varied activities of manufacturing, machine design, sales and distribution, as carried on by the great army of workers in that organization, have made possible abundant opportunities to the ambitious and alert employee. Lectures, classroom discussions, observation and inspection trips, reading assignments and personal conferences, are all valued and effective means of training.

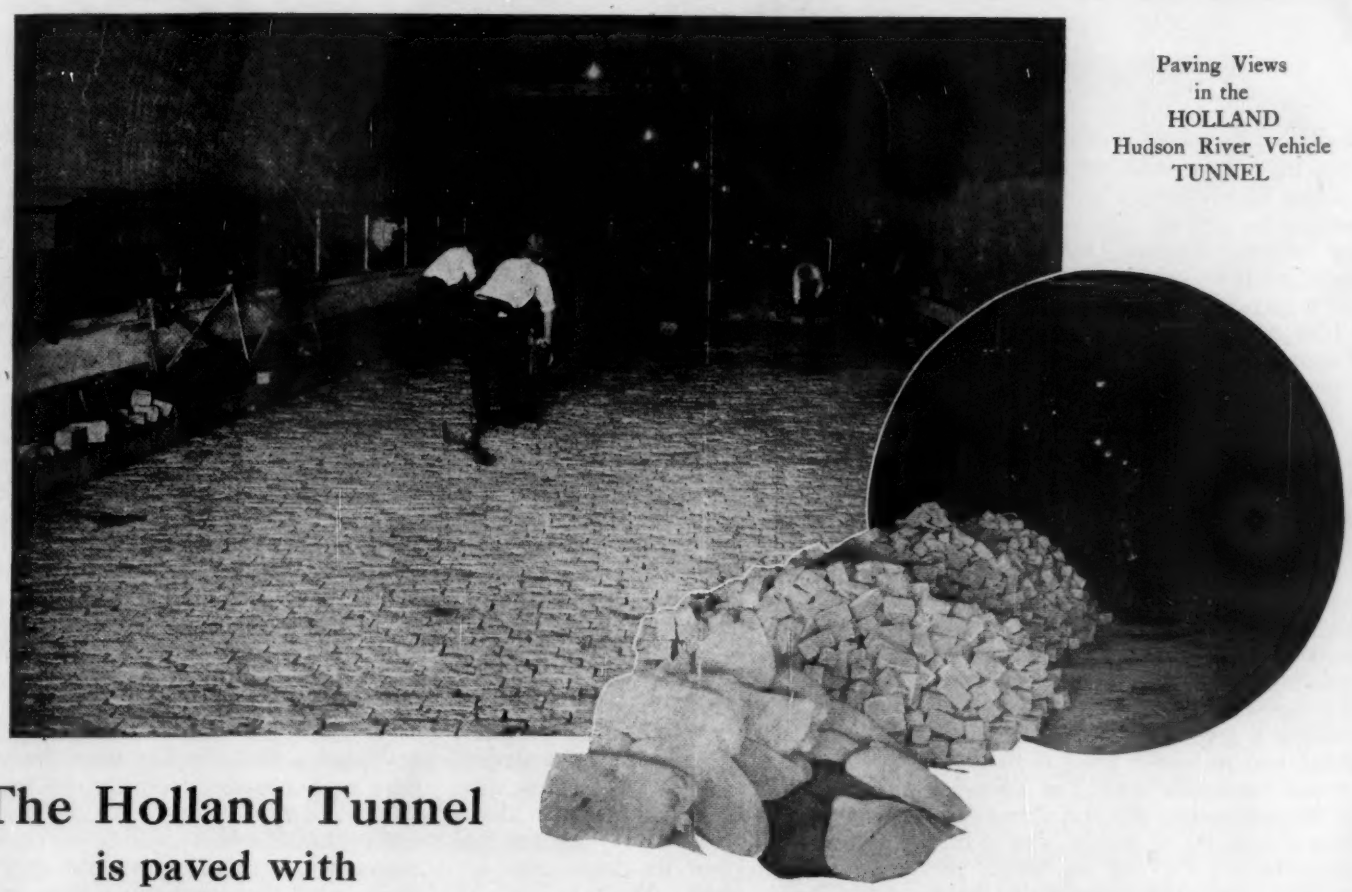
The aim of these courses of study and observation is to enable the participants to utilize their training and ability in a productive way as far as practicable. Assignments to definite jobs require close co-operation and personal contacts, enabling each to develop those faculties necessary as promotions come to positions of supervising and directing the work of others.

Opportunities in the Bell System

The broad purpose of the training which has been outlined is the more adequate preparation of those who pursue them to assume the new and greater responsibilities which its rate of growth is constantly imposing on the Bell System personnel. Commenting on this growth, Mr. Gifford, President of the American Telephone and Telegraph Company, said recently:

"This year [1924], for instance, we are building gross construction of $360,000,000. In the planning and development of this work it is quite obvious that the greatest care must be taken that we always adopt the best, that we make no mistakes in our plans, and that we engineer the entire program on sound lines. This is one of the reasons why we require so many technical men in the business."

Promotions, both as regards responsibility and salary, do not depend upon length of service. Merit receives prompt and proportionate recognition, and due to the rate of growth of the industry there are always openings ahead.



Paving Views
in the
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Hudson River Vehicle
TUNNEL

The Holland Tunnel
is paved with

GRANITE PAVING BLOCK

Forty-five thousand square yards of modern Granite Block pavement are being put down in the $42,000,000 twin-tube Holland Tunnel under the Hudson River, by W. J. Fitzgerald, N. Y.

This great tunnel is designed to handle 46,000 vehicles every 24 hours on its two 20-ft. wide roadways.

The paving must cause no trouble—no repairs—no delays. The tunnels must be kept free and clear for the continuous flow of traffic. There must be no dust—no wear. It must be smooth—quiet—and *stay* that way.

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These blocks, 7 to 11 in. long, 3¾ to 4½ in. wide, averaging 4 in. deep, are laid on a cement-sand cushion over a reinforced concrete foundation, and are closely jointed and thinly surfaced with an asphalt-mastic filler.

On this smooth, everlasting Granite Block pavement the wheels of thousands of motor cars and trucks traveling underneath the Hudson River between New York and Jersey City will roll for years without noise or jolts, without wear.

The choice of modern Granite Block pavement for the Holland Tunnel is an example of far-sighted economy and efficiency that should point the way to perfect paving for municipalities everywhere.

A Booklet of interest to engineers,
"Granite Street Construction"

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31 State Street, BOSTON, MASS.

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Editorials

(*Continued from page 232*)

Building codes and other requirements inevitably will lag behind the forefront of progress. There are advantages as well as disadvantages in this. When, however, the need for reform is felt by certain engineers, and is then recognized as really important by a large majority of their colleagues, the growing influence of the profession as a whole will probably be sufficient to bring about the changes desired. In the present instances, it remains for the great body of engineers most vitally affected to pass judgment. Whether the proposal represents a real advance or not, it would still seem to be true that some of its effects would have much in common with those which must result from all engineering progress. It might be profitable to consider what certain of these might be.

In the first place, such a change would be a very real expression of confidence and so would bring in its train renewed responsibility. The editorial and the address mentioned above furnish a clue to the probable form of this responsibility. On the one hand, the activities of the charlatan would have to be curtailed, and real competence would become more important than ever. On the other hand, renewed vigilance would be necessary over the quality of material and workmanship involved in construction. These are not new objectives. The reward of good work is very often more and harder work. Any movement prompted by a real desire for progress must of necessity be disinterested. Here there would seem to be something of a test to apply to such movements. If the realization of its object will bring to the supporters of any proposal no obvious or immediate gain, but rather increased responsibility and necessity for effort, there can be little doubt as to the genuineness of that proposal.

NEW LIGHT PLANE

The so-called "Light Plane" of today is the logical outcome of the many experiments conducted with gliders during 1922 and 1923. The new low-powered planes were developed by the application of motors of only a few horse-power to machines constructed along the general lines of gliders employing a light wing-loading. However, another school of designers has long maintained that the most satisfactory results with low power could best be attained by working down from the conventional characteristics of the ordinary heavy airplane, keeping the wing-loading and the proportion approximately the same.

The advocates of the latter method won a signal victory in the complete triumph in this year's races of the new Powell Plane, which won first place in both the speed and efficiency contests, and then amply proved its practical ability by climbing to 10,000 feet with ease. The new machine looks like a conventional single-bay biplane of normal form, but its dimensions are surprisingly small. With a span of only 18 feet, a length of 14 feet, and a height of 5 feet, the ship is truly a "pocket edition." The weight is so low that it can be lifted clear of the ground by one man.

The tiny plane is powered with a Bristol "Cherub" motor, a horizontally opposed twin developing 10.7 h.p. This motor was especially built for Light Plane use, and is the first one of its kind to appear in this country, although many of the successful, small British planes have used it. The little motor pulls the ship along at 80 miles per hour and gives a very fast take-off and rapid climb. Because of its small area and relatively high wing-loading the little plane lands faster than is customary, but it sticks to the ground well and pulls up in a remarkably short run, with no indication of the objectionable "floating" that is characteristic of most Light Planes. The constructional and maintenance characteristics are excellent, and the plane is reported to be very comfortable to fly.—*Aviation.*

New Fertilizer Now Available

It has long been realized that urea, an organic compound almost unknown outside the chemical laboratory, is the most suitable fertilizer for use with all kinds of soils. It can be used alone or as a component of mixed fertilizers, and needs no experience in handling. The only reason it is not now used is the inability to produce it on a commercial basis at a price low enough to compete with other fertilizers.

At an experimental plant erected at Niagara Falls, it has been proved that urea can be produced in large quantities at a low cost. At this plant, compressed carbon dioxide is blown through a solution of calcium cyanamide, and the solution is then violently agitated so that the water and carbon dioxide react with the calcium cyanamide to form calcium carbonate, and cyanamide is set free. The cyanamide is then hydrolyzed, with the aid of sulphuric acid, to form a solution of urea. This solution is then filtered, and the water evaporated. The molten urea can be run at once into drums and shipped to a mixing plant. If it is to be used directly, a stream of cold air is passed through the urea as it is poured out of the vacuum pan, and causes it to break up into small droplets of the correct size which solidify with a glazed surface. This is necessary to prevent deterioration, as urea is slightly hygroscopic.—*Chemical and Metallurgical Engineering.*

The **KELLER METHOD** is now used by the leading progressive industries. DIES, MOULDS, METAL PATTERNS and COREBOXES, ROLLS of almost every variety are AUTOMATICALLY reproduced from a master form or a template.

The PRINCIPLE of the Keller Machines is that of a cutter or milling tool working in unison with a tracer or guide following either automatically or with hand control.

More than twenty-five types are made.

KME KELLER MECHANICAL ENGINEERING CORPORATION KME
70 WASHINGTON STREET, BROOKLYN, N. Y.

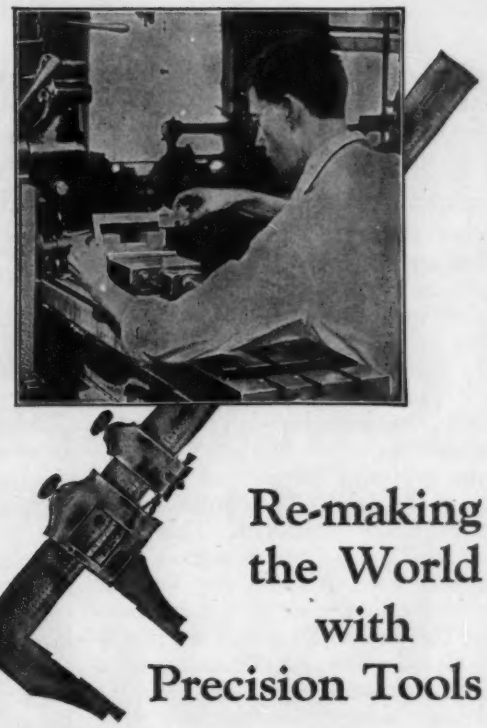
DAYLIGHT ILLUMINATION.

The angle of refraction being equal to the angle of incident, it is a simple matter to determine the correct angles to use in manufacturing glass which will give good illumination. But for proper industrial plant illumination, there is more to be considered than mere deflection of light. The direct beam of light must be eliminated in order to prevent sun glare, which is objectionable on account of its causing heavy shadows and strong contrasts which decrease the efficiency of employees and necessitate the use of shades which in turn reduce the light to such an extent that daylight illumination any distance from the light source is not sufficient. Therefore, in order to produce a glass which when used in the windows of industrial plants will produce as near to ideal illumination as possible, we must first eliminate the direct rays of the sun by deflecting the light to the ceiling and side walls which re-deflect it back to a distance 25 to 50 feet from the window throughout the entire working area. To accomplish this we have scientifically designed a type of glass which is named "Factrolite."

Factrolite consists of 30 ribs to the inch, running at right angles, forming 900 pyramidical prisms or 3,600 light deflecting surfaces which completely disintegrate the direct beam of light from the sun. Furthermore, the depressions in the surface of Factrolite are so slight that the accumulation of dirt and dust is minimized and can be perfectly cleaned with an ordinary dry scrubbing brush. Incidentally, the cleaning of windows is most important for keeping up production and increasing the efficiency of any industrial plant and should be given more consideration in plant management.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.

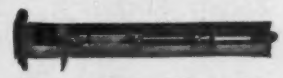


Re-making the World with Precision Tools

IT is difficult to comprehend the tremendous changes made possible in the world by the introduction of practical precision tools. The astounding mechanical progress of the past 50 years, which has completely changed man's environment, would have been impossible without them. They place within reach of all the standards without which working methods in the metal trades would be primitive.

The vernier as a mechanical principle of indicating very small dimensions was invented by Pierre Vernier in 1631. The first practical application of the principle to a measuring tool for metalworkers was not made, however, until 1851, when Jos. R. Brown invented the Vernier Caliper.

The manufacture of this highly useful tool by the Brown & Sharpe Mfg. Co., dated from that year. Today, hundreds of styles and sizes of tools embodying the vernier, and measuring to one thousandth of an inch, are made by this company and distributed all over the world.



The first and original Vernier Caliper, so far as is known, invented in 1851 by Jos. R. Brown, the founder of the Brown & Sharpe Mfg. Co.

BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

The Phonofilm

(*Continued from page 227*)

fine slit having the same dimensions as that in the camera, upon the photo-electric cell, which is a few inches in front of the slit. Across the slit, and in close contact therewith, passes the film on which the original photographic image of the sound has been photographed and printed. The fine lines of light and dark which represent the sound record, passing across the tiny slit, produce corresponding variations in the light beam which transverses the slit and falls upon the photo-electric cell. Now in series with this photo-electric cell are connected a dry-battery and the grid and filament of the first audion of a specially designed five-step audio-frequency amplifier. This amplifier, which has been designed with the utmost care to avoid any form of distortion, magnifies the minute telephonic currents thus generated in the photo-electric cell by the order of a hundred thousand times. The output circuit of this amplifier is then connected by means of electric wires to the loud speakers which are concealed behind, or directly around the screen, on which at the same time the original picture is being projected.

Note now the all-important part which the audion plays in the talking motion picture, or, as I prefer to call it, the Phonofilm. First, we have an amplification of the order of five thousand to one hundred thousand times of the original telephonic currents, then an oscillating audion generating the high-frequency energy for lighting the Photion tube, and another audion, acting as modulator to control the high-frequency output of this oscillator. Then, at the reproducer, we have again a multi-stage audion amplifier, thus giving in all an amplification, from the original transmitter near the camera to the final loud speaker at the projection screen, of the order of several million times. I do not mean by this to state that the reproduced voice you are hearing is several million times as loud as the voice that made the record! There is between the photographing of the voice on the film and its reproduction in the photo-electric cell, a very great diminution in intensity, which diminution must be made good, and in addition amplified thousands of times in order to permit the loud sound which is required to fill the auditorium.

I have employed two types of photo-electric cells with my reproducer. The so-called Kunz potassium-mirror, photo-electric cell, and the less known but more sensitive "thalofide" cell of Theodore W. Case. However, on account of a certain lag which impairs to a degree the clarity of reproduction of the higher sound frequencies I prefer the Kunz cell.

Of all the diaphragm types of transmitters, unquestionably the electrostatic type, as perfected by engineers of the Western Electric Company, comes nearest to approximating perfection, although this is extremely insensitive compared with the best carbon microphone type.

Passing now to the loud speaker, or reproducer, the last step in the many translations which I have been describing, I am pleased to say that we are no longer limited to the use of a diaphragm and horn. Although the loud speaker has been developed to a high state of perfection, notably again by engineers of the Western Electric

(*Continued on page 244*)

BAY STATE
DREDGING & CONTRACTING CO.

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River and Harbor Improvements

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View showing tug *John Cashman*, with Dredge No. 4 in the distance, while dredging on the eastern end of the Cape Cod Canal during the Spring of 1925.

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East Boston 1834 *and* 1835

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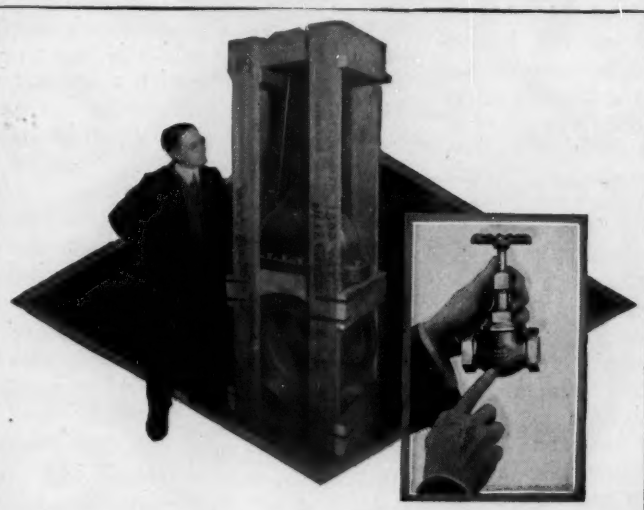
Always marked with the "Diamond"
Jenkins Valves
SINCE 1864



Brothers in the Jenkins fraternity

THE small inch-and-a-quarter bronze globe valve and the large iron body gate valve—both are Jenkins. Jenkins Valves range in size from eighth-inch to valves so large that a man could walk through them.

There are Jenkins Valves for practically every requirement, for controlling the flow of water, oil, gas, air and other fluids—in power plant, plumbing, heating, fire protection and other service.

These valves are built to do their jobs and do them well—designed, made, tested and guaranteed for the maximum service, not merely the average.

You can tell a member of the Jenkins fraternity by the Jenkins "Diamond" mark cast on the body of the valve.

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The destructive enemy of sheet metal is *rust.* It is successfully combated by the use of protective coatings, or by scientific alloying to resist corrosion. Well made steel alloyed with Copper gives maximum endurance. Insist upon

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Keystone Copper Steel gives superior service for roofing, siding, gutters, spouting, culverts, flumes, tanks, and all uses to which sheet metal is adapted—above or below the ground. Our booklet *Facts* tells you why. We manufacture American Bessemer, American Open Hearth, and Keystone Copper Steel Sheets and Tin Plates.

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Our Sheet and Tin Mill Products represent the highest standards of quality, and are particularly suited to the requirements of the mining, engineering, and general construction fields. Sold by leading metal merchants. Write nearest District Office.

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Pacific Coast Representatives: UNITED STATES STEEL PRODUCTS CO., San Francisco Los Angeles Portland Seattle
Export Representatives: UNITED STATES STEEL PRODUCTS CO., New York City

The Phonofilm

(*Continued from page 242*)

Company, there is still room for improvement.

While seeking to improve the efficiency of available methods for conveying the action of the electro-magnetic telephone motor to the air, it occurred to me to apply this mechanical impulse to the edge of a large rectangular membrane, instead of to the central point of a diaphragm or paper cone. This solution proved strikingly simple — to curve the surface and then apply the impulse tangentially rather than normally to the surface, as invariably heretofore. There is thus practically no limitation to the area of the surface to be employed, as long as the motor is of appropriate power. Every portion of the membrane thus enters into the action, in the form of surface displacement waves which course over the surface from the source. The air envelope is readily put into agitation at all frequencies, down to the lowest audible limit. With adequate power in the driving motor the highest notes are reproduced from the large areas of the AUDALION with surprising fidelity.

The question is often asked, "What happens when the film becomes torn? Is not synchronism lost in a film that has been patched together?" Where pictures are taken, as here, at the rate of twenty to twenty-two per second, one or even two "frames" may be cut out of both voice and picture records without the flaw in exact synchronism being observable. This holds true even though the picture is some ten inches ahead of the corresponding voice record. However, the sharpest ear will hardly notice the omission from a voice or music record of a portion occupying not more than one twentieth part of a second.

Of course, should a film become badly torn, or worn out, it must be replaced by a fresh print, as in any motion-picture film.

A comparison of the photographic records of various sounds, as of the five vowels, is interesting. Some of the patterns here are very pretty and symmetrical — that of the letter E particularly.

We have often heard comparisons of light with sounds. Here, on the Phonofilm, we have them both truly interlinked — Sound registered and interrupted by Light — Light waves have become the carriers of sound waves, and we have here caused Sound to write its autograph in Light.

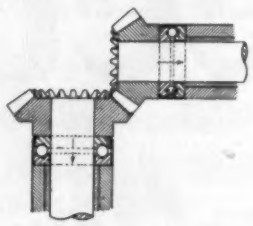
These symmetrically beautiful, but ever-varying lines of light are indeed "sound shadows" — long sought by the poets — "photographic echoes" which can resound and reverberate, and re-echo, again and again, with all true color of tone and fidelity of phrasing, whenever it pleases one to again pass light athwart these shadows!

Crankless Diesel Engine. Many attempts have been made to do away with the bulky and inefficient crankshaft in automobile or airplane engines. The idea of using a wobble plate has been tried by several engineers, but always resulted in failure. Now a New York firm claims that they have produced a practicable engine of this type which is just as efficient as an engine with a crankshaft, but takes up only about half as much room and weighs less. In this engine, a plate is fixed at an angle of 45 degrees on a shaft, and the cylinders spaced equidistantly around the periphery of the plate. When the explosions take place in the cylinders, the motion of the pistons is transmitted to the side of the plate by means of sliding balls and sockets, in such a way that the plate tends to rotate. The cylinders are fired in order so that this rotation becomes continuous, and the shaft is thereby turned at a constant speed.—*Marine Engineering.*

Carboplastic Cement. The principal ingredient of this new cement is carborundum, a highly refractory material. Because of properly selected bonding material, the cement retains the refractive property of the carborundum and at the same time lends itself to application with a gun. The cement is prepared simply by the addition of water to give it the proper consistency. It sets in air with a strong bond, resisting high temperatures better than the best fire-brick. It can be applied to either hot or cold settings.

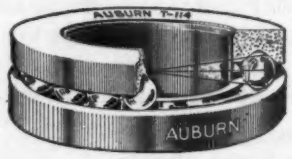
The principal uses of carboplastic cement are in minimizing the serious effects on fire-brick settings of localized flame impingement, of cavities due to spalling and cracking, and of clinker formation. The rate of application is about fifty pounds in less than half a minute. The gun weighing but twelve pounds may be operated by either steam or compressed air at a pressure of one hundred pounds.—*Compressed Air Magazine.*

BEVEL GEARS



have longer life when their thrust is taken by

AUBURN BALL THRUST BEARINGS



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Steel, Brass and Bronze Balls

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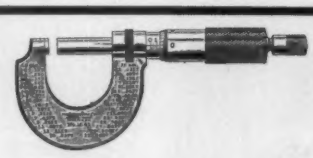
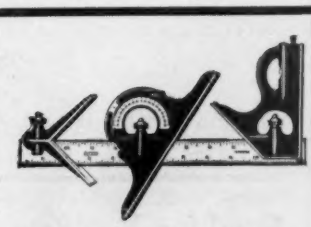
Trade Mark

LUFKIN TAPES RULES



LUFKIN SMALL TOOLS



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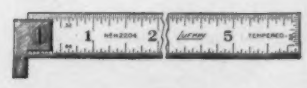

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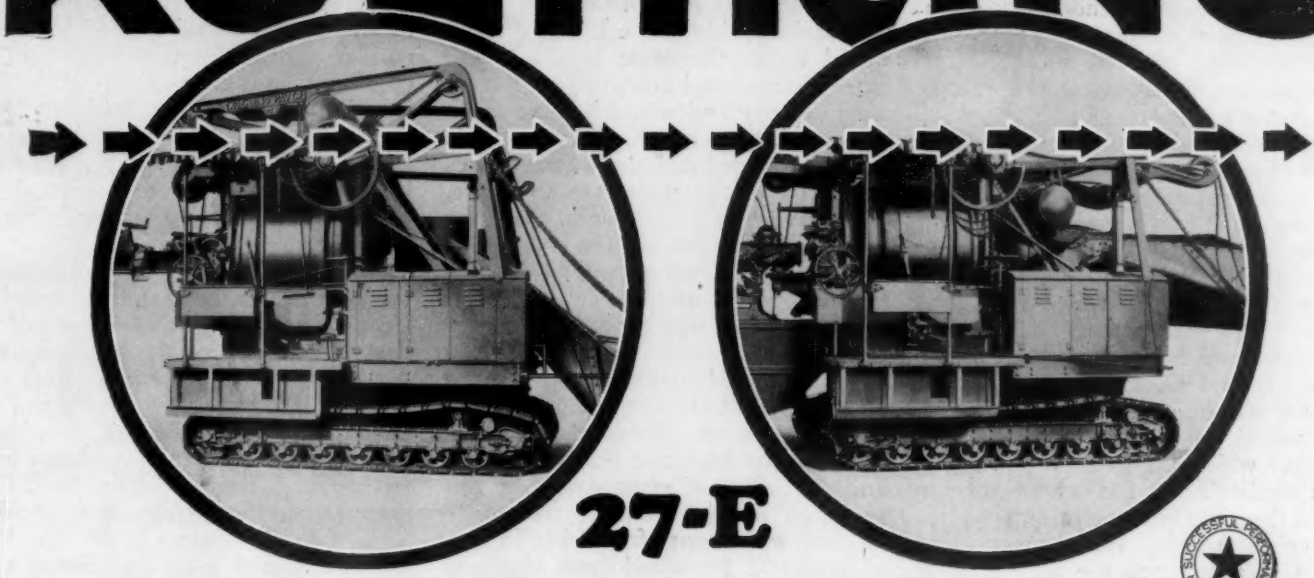

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KOEHRING HEAVY DUTY

A-3010-I

The Passamaquoddy Tidal Power Development

(*Continued from page 225*)

Bay, would be 300 feet by 60 feet by 15 feet.

The variation in the water levels of the two pools may be understood from the accompanying diagram (Fig. 2), in which time is abscissa and height of water surface the ordinate. We recognize that the tide ebbs and flows twice in twenty-four hours, and the curve ABDFH may be considered to represent the rise and fall of the tide.

If the upper pool were assumed to be full at D and the gates in the dams closed, then with the turbines running, the water surface in this pool would drop at some such rate as DG. As the tide rises from low tide at F, it would come to level G, at which time the gates would be opened and the upper pool would rise to high-water level at H, after which the gates would again be closed. Then the water surface would drop at the same rate as before. In other words, the broken line ACDGH represents the approximate variations in the level of the upper pool.

If the lower pool were considered to be at its lowest level at B, that is, at low-water level, the gates into the Bay of Fundy would be closed and, as the water passed through the power house, the water surface would rise at some such rate as BE. As the tide ebbs, following high tide at D, it would reach a level at E such that the lower pool and the tide in the Bay of Fundy would be at the same level. If the gates were opened now, the lower pool would empty and would in time reach the low-tide level at F, when the gates would be closed and the water surface again rise at the same rate as before. The curve BEFJ represents, then, the variation in the level of the lower pool. The vertical distance from the curves for the upper and lower pool thus represents the total gross head on the plant at any time. After deducting entrance and penstock losses from this head, we have the net operating head on the turbines. From the diagram it is evident that this head will vary, and Mr. Cooper estimates that this variation will be from 24 feet to 10 feet and will average from 14 to 15 feet.

It should be noted here that the curves, as shown, are subject to modification. In order to fill and empty the upper and lower pools, respectively, in the brief time available, a high velocity through the gates is necessary. This velocity would be obtained by delaying the opening of the gates long enough to create a difference in the levels of the water on both sides, this difference representing the velocity head. The details involved in filling and emptying the two pools require careful calculations, since it is imperative that the upper pool should be completely filled just as the tide begins to ebb following high water, while the lower pool should be at low-water level just as the tide begins to flow following low tide.

To develop the power, hydraulic turbines are to be installed, and Mr. Cooper is planning to use wheels of the propeller or suction type. While this type is only about twelve years old, already 100 have been built and installed in the United States. The heads on the plants which have been built have a range from 22 inches to 35 feet, and the specific speeds are from 90 to 250, English system (400 to 1100 metric). From past experience with this type of wheel, it is anticipated that this plant will operate with little difficulty. Other plants are operating now under a varying head. One of the latest installations is that of the Wynau

(*Continued on page 248*)

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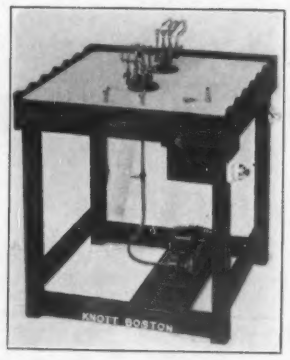

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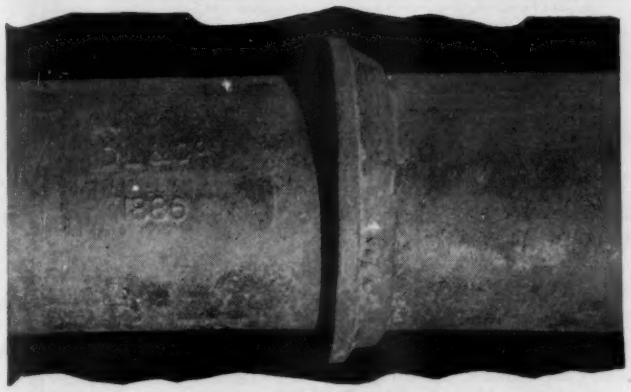

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The Passamaquoddy Tidal Power Development

(*Continued from page 246*)

Electricity Works on the Aare River in Switzerland. There are two units in this installation, each of 2700 horse-power and operating under a head varying from 8.2 feet to 17 feet at 107 r.p.m. When operating under the former head the efficiency is 85 per cent; while under the 17-foot head the maximum efficiency is 89 per cent.

The propeller type unit has a steep load-efficiency curve so that operation at part gate is accompanied by a marked drop in efficiency. At this plant it is intended to run a number of the wheels at the gate for maximum efficiency and adjust the plant output to the plant load by regulating as small a number of wheels as possible. It is therefore proposed that about 70 per cent of the units have no gates and that these be always operated at full load.

For the initial installation Mr. Cooper is planning for 35 turbines, each with the output varying from 14,000 to 20,000 horse-power, according as to whether the head is low or high. This gives a plant capacity of from 500,000 to 700,000 horse-power and a yearly estimated output of 3,270,000,000 kilowatt hours of primary power. It is of interest to note that when the plant is developing 500,000 horse-power under a 15-foot head, the flow through the wheels will be about 360,000 cubic feet per second, or about 1¾ times the flow of the Niagara River at Buffalo. If we assume that this is an average draft, and that it continues for the twelve hours from low tide to low tide, we have about 15½ billion cubic feet of water to be passed through ten gates each of 6300 square feet cross-section. Mr. Cooper estimates the time for emptying the lower pool as 220 minutes. The average velocity of water through the gates will then be about 18½ feet per second, or 12½ miles per hour.

The energy generated at this plant is to be brought to the consumer over a transmission line which, it is estimated, will cost $17,000,000. Markets will be sought as far south as Boston, Mass., and north into Canada.

Several important details must be successfully attended to before this work should be begun. Already, engineers are keeping a record of the variation in the tides so that all hydraulic computations will be correct. If the velocity of water through the gates approaches the high velocity of 18½ feet per second, as computed from Mr. Cooper's figures, it is obvious that serious problems are to be faced in the design and construction of the gates and waterways as well as the power house itself.

In the past many proposals for tidal-power developments have been abandoned because of the excessive estimated cost per horse-power of the installation. This cost must be carefully estimated and it must be sufficiently low to bring the cost of the electricity to the consumer as low as that now produced by hydro-electric or steam plants in the vicinity of the regions to be served. These estimates should provide a reasonable return on the $100,000,000 of capital invested. Just the collecting of this sum, and its wise expenditure during the five years of construction, would be quite a task.

Since there are no tidal projects, at least of any size, which are developing continuous power at present, the many new problems which will arise on this type of a project should be anticipated in so far as possible and satisfactorily answered before work is begun. If all of the above conditions are fulfilled, and the project appears to be feasible, work may be commenced, and in turn this immense store of energy would be made ready to serve mankind.

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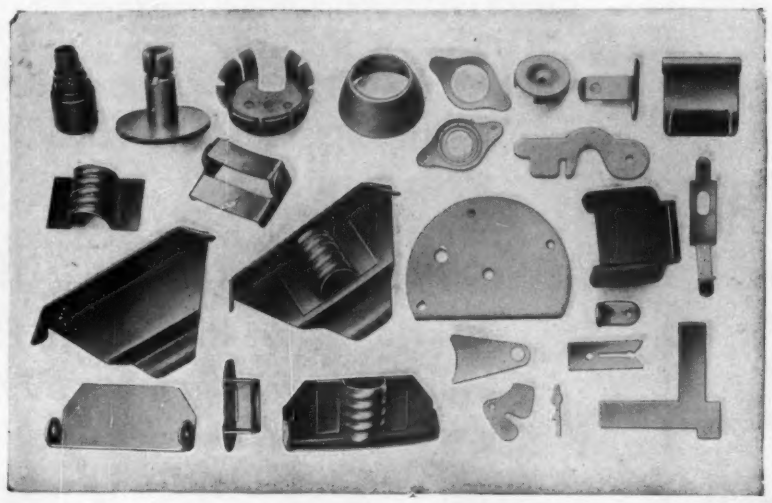

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Model Basin Theory and Practice

(*Continued from page 230*)

nearly experimental data obtained by towing large diameter pipes up to 60 meters long in a model basin. Whichever formula is used, the calculation of the total resistance of the ship is the same. Calculate the frictional resistance of the model by formula, subtract this from the measured model resistance, expand the remainder by Froude's law of comparison, i.e., multiply by the cube of the linear ratio, and add to this the calculated frictional resistance of the ship. The horsepower is then simply given by the expression $1.024 \times \frac{R_s \times 101.33\ V_s}{33000}$

V_s being the ship speed in knots and 1.024 the nominal specific gravity of salt water. This power is called the Towrope or Effective Horse-power.

Up to about ten years ago the model of the several alternative designs having the lowest effective horse-power was regarded as the best. However, this may not be the case. From the money point of view we are not so much interested in the effective horsepower as we are in the shaft horsepower, i.e., the power we have to deliver to the propeller in order to drive the ship at a desired speed. In other words, we also must take account of the unavoidable losses that occur in the transformation of the rotary energy produced in the engine to the energy pushing the ship through the water, and the shape of the hull has a very decided influence on these losses. The biggest losses occur in the propeller itself. The major ones are: the kinetic energy carried away in the propeller race, friction and eddy losses, and the rotational motion imparted to the propeller race. Part of the latter is today very successfully recovered by a device called the Contrapropeller; in single-screw ships fitted with this device gains in efficiency of from 10 to 15 per cent have been recorded. In addition to the other losses we have what is generally called Thrust Deduction. This loss is caused by the propeller having a suction effect on the ship; in full-bodied ships it may amount to 30 per cent or more of the total thrust. Another complicating influence that is rather a source of gain than a loss is the Wake. This term is applied to a forward current induced by the motion of the ship. Of course these influences can be approximated, and, as a matter of fact, the Wake and Thrust deduction must be assumed in the first design of the propeller. However, the careful naval architect will not be satisfied with this, but will check up on his calculations by a test with the self-propelled model.

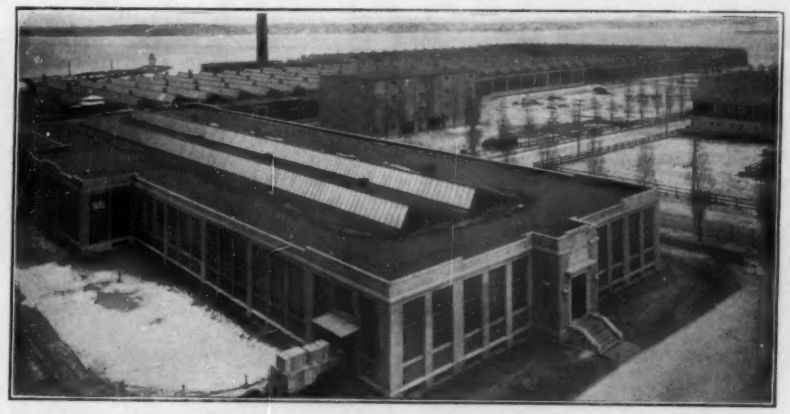
Although admittedly the self-propelled model method has several theoretical flaws, it gives remarkably good results when compared with the trial-trip results of the full-sized vessel.

Self-propelled model tests now form a large part of the work of the United States Model Basin in Washington. For this test the model is fitted with all appendages exactly made to scale. The propellers are also exact-scale reproductions of the ship's propellers. Electric dynamometers are used to drive the propellers, at the same time recording propeller thrust, torque, and revolutions, and time. From these data a complete analysis can be made giving not only a solution of the problem in hand, but also serving as a foundation for future designs. Besides this, the self-propelled model method has many other uses. For example, the development of the Contrapropeller and the Flettner Rudder would have been almost impossible without it on account of the difficulty and prohibitive cost of experiments with full-sized ships. The relative merits of the stern-wheel towboat as compared with the tunnel-screw towboat when towing or pushing a long train of barges—a bone of contention for years among river men — is another interesting problem. This question was recently quite exhaustively investigated with self-propelled models in the Washington Tank. The measuring of rudder forces, the turning circle of a ship, the power loss due to steering, and many other interesting self-propulsion problems, have been investigated.

The model basin has thus become one of the greatest money savers and aids to the shipbuilder; it compares in usefulness to the great industrial laboratories maintained by the Government and private industries.

Eliminating Carbon Monoxide. For some time, automotive engineers have been trying, rather unsuccessfully, to eliminate the carbon monoxide in the exhaust gases of all forms of internal combustion engines. Carbon monoxide is a deadly poison, and with the increasing use of automobiles, the pollution of the air in our large cities has reached a serious aspect. Carbon monoxide is the chief constituent of producer gas, and is used for a great variety of purposes in this form.

The Thompson Laboratories have just announced a system by which the disposal of this gas is effected. The gas is present in too small an amount to be ignited by ordinary methods, but by using certain catalytic agents the gas can be ignited and burned to the harmless gas carbon dioxide.—*Automotive Industries.*



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The New Course in Ship Operation

(*Continued from page 221*)

arrangement of the machinery and piping than to the actual design of prime movers. Aside from the drawing room work in marine engine design, the students in the new course will devote the same amount of time to marine engineering as the regular students in Naval Architecture and Marine Engineering.

A feature in the new schedule of studies will be the specially prepared courses in shipping administration and the economics of ship operation. The course in shipping administration will be given by Professor Hanson of the Department of Economics and Statistics, who has made a special study of this subject in the various steamship offices in New York. The course will take up freight and passenger traffic, the papers used in the shipping business, chartering, ship brokerage, agreements and conferences, wharf management, and marine insurance. Some time will also be devoted to admiralty law.

The handling of ship's cargoes is not only one of the largest expenses in connection with ship operation, but it also fixes the ship's turn-around, and thus has a twofold influence on profits. A study will be made of ports and terminal facilities together with the methods of handling and stowing cargoes, piers, cranes, railroad facilities, and other factors involving a quick turn-around of the ship in port.

The course in ship operation given in both terms of the senior year is one of the most valuable features of the new option. It will take up many of the engineering and economic problems of ship operation and management. Typical problems in ship operation will be worked out and the annual operating expenses and profits calculated for given ships on assigned trade routes. Comparative studies will be made of the operating expenses with different kinds of fuel and types of propelling machinery, both steam and Diesel. Other subjects taken up in this course will be the influence of the size and speed of ships on operating expenses and receipts; influence of cargo handling speeds and costs; repairs, upkeep, and docking; economic operation of the propelling machinery and auxiliaries; and a comparison of the types of ships and machinery for different trade routes. This course will allow the student to apply to actual problems many of the principles of naval architecture, marine engineering, and ship design which have been treated earlier in his course.

As an actual contact with ships and the shipping business is very essential for the undergraduate while he is pursuing his course, the students will be encouraged to obtain summer employment on board ship and in the offices of the steamship companies.

The following table has been prepared to show a comparison of the time devoted to the major groups of studies in the regular and new options of Course XIII:

	$XIII_1$ %	$XIII_2$ %
Chemistry, Physics, Math., Drawing, and MS and PT	36.5	36.0
English and General Studies	12.1	10.2
Economics	4.6	19.3
App. Mech., Hydraulics, Heat Eng., and Elec. Eng.	19.7	16.0
Shop	4.1	1.5
Naval Arch., Ship Const., Ship Design, Mar. Eng., Ship Operation, etc., and Thesis	23.0	17.0
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OUTLAST THE BONDS

The Piece Rate System in Industry

(*Continued from page 231*)

Under this plan, if a few of the shoe workers in a department of the factory were without work for more than a half-hour period any time before 11:00 A. M., all the workers in the department would quit work until the following day. This was a severe penalty for both the manufacturer and worker, but it forced the manufacturer to give more consideration to this phase of the piece worker's working-conditions.

A continuous supply of work throughout the day necessitates not only careful planning and routing of work, materials, and supplies, but also requires instruction of the responsible person, usually the foreman, in the importance of keeping only enough men on the job to get out the work. If done, this will result in the maximum amount of work for each man, the maximum amount of pay for him at the end of the week, and the lowest piece rates and labor cost consistent with adequate earnings for the operation. As the natural inclination of many foremen is to over-organize their lines of operators in order to "play safe" against unforeseen contingencies of absences, machine trouble, or other delays which may prevent them from getting out their day's work, and as the usual policy of the workers is to ask that all men be retained and "share and share alike" when the factory production is less than normal, the obtaining of high earnings with low piece rates is a matter that requires constant attention on the part of the factory management. Many "low-price" factories, which appreciate the importance of this point, are better places to work in, from a financial standpoint, than "high-price" factories with unsystematic control of production and personnel.

The third condition necessary for the success of a piece-rate system — provision for instruction and compensation of apprentices, beginners, or "learners," whichever term is desired — varies in importance with the conditions in the industry. Some industries have operations where they are able to hire only skilled workers; others have operations where apprentices can start on piece work and earn a day's pay the first day. During periods of unemployment and oversupply of labor men have frequently worked on piece work for practically no compensation except the opportunity of learning a good trade.

Apprentice Systems

In recent years, manufacturers have usually found that some additional compensation is needed to take care of an operator during the "apprentice period" when he is acquiring his skill and speed on a piece-work operation. Several plans have been used successfully, their advantages being dependent upon the particular conditions to be met with regard to length of time necessary to learn the operation, amount of labor available from those who desire to learn, competitive rates paid by other manufacturers, etc. The plans most frequently used are:

(a) A guaranteed weekly wage until piece-work earnings exceed the guarantee.
(b) A guaranteed weekly wage for a limited period, after which operators are paid piece-work.
(c) Piece-work earnings plus a definite weekly bonus for a limited period.
(d) Piece-work earnings plus a weekly bonus which decreases in amount each week until it "runs out" at the end of the "apprentice period."

When properly installed and operated, the simplicity and fairness of the piece-work system recommend themselves to the great majority of employers and employees, as is shown by the large number of industries using this form of compensation. In the shoe industry alone many plants can be shown where over ninety per cent of the employees are working under this plan, the only "day workers" being the salaried foremen and the few so-called "nonproductive" workers such as inspectors, cobblers, shippers, lumpers, watchmen, etc.

Other more complicated payment plans are used successfully; some are the best that can be devised to meet the particular conditions of an industry, but none have as yet shown the general adaptability and found the wide application of the ordinary piece-work payment plan.

Toxicology, or, The Effects of Poisons. By Frank P. Underhill. Philadelphia: Blakiston, 1924.

This is a concise systematic account of the effects of a great variety of poisons upon the human organism. They are treated in the following groups: Inorganic Poisons (corrosive acids and alkalies), Poisonous Gases, Metallic Poisons, Alkaloidal Poisons, Organic Poisons. The book is based upon a course of lectures to students in the Yale School of Medicine.

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Buff & Buff Mfg. Co.
Jamaica Plain, Mass.

BUFF

SAMSON SPOT SASH CORD

Trade-Mark Registered U. S. Patent Office

Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS -:- 88 Broad Street, Boston 9, Mass.

Lab Lightning

Douglas F. Miner

SOME of the men at Clark University mentioned it first. "Doug surely lives in the Lab," they remarked. Later, too, at Worcester Polytechnic Institute, instructors made the same comment. And Douglas F. Miner, himself, agrees that he did—and does. That makes it unanimous.

"Big league lab work" was his aim as he turned to Westinghouse after graduation in 1917. But not until his return from overseas service two years later could he settle down to the lab. Now—at thirty-three—he's in charge of experiments at our Engineering, High Power, and High Voltage Laboratories, with a staff of twenty-five to direct.

He can unleash artificial lightning of 5,000,000 horsepower in 5/1000 of a second. At his bidding the world's largest single-unit transformer will step current up to a million and a quarter volts.

He has demonstrated the greatest artificial arc on record—fifty-five feet in length. To further his experiments a single generating plant, capable of producing on short circuit a million horsepower, has been erected.

There is a practical reason for these super-tests—for this equipment in advance of what the world uses now in its daily work. This, for instance, is frequently the attitude of a Central Station customer: "Of course your apparatus meets our needs today—takes every test to which we can put it now. But what of 1950? Will this insulation stand the load we will use then? And how many volts will these arresters bear?"

They come to Miner for the answer. He gets it from the laboratories. He produces under a roof the same conditions which nature, or time, may be holding in store for Westinghouse equipment.

Such is the pioneering of Westinghouse Laboratory Engineers. They are "experimenting in the tomorrow"—the step between research and application. They are finding growth, reward, congenial work, while following a bent for trying things out.

The question is sometimes asked: Where do young men get when they enter a large industrial organization? Have they opportunity to exercise creative talents, or are they forced into narrow grooves?

This series of advertisements throws light on these questions. Each advertisement takes up the record of a college man who came with the Westinghouse Company, within the past ten years, after graduation.

Westinghouse

WESTINGHOUSE ELECTRIC

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASS.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY offers courses, each of four years' duration, in Civil, Mechanical, and Electrical Engineering; Naval Architecture and Marine Engineering; Mining Engineering and Metallurgy, and Geology; Architecture and Architectural Engineering; Chemistry, Chemical Engineering, and Electrochemical Engineering; Biology and Public Health, and Sanitary and Municipal Engineering; Physics, General Science, and General Engineering; and in Engineering Administration. These courses lead to the Degree of Bachelor of Science.

To be admitted to the first-year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfil entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German, and one elective subject. Examinations are required in all subjects except Chemistry, History, and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy, and Doctor of Science are also offered. Special Research Laboratories of Physical Chemistry, Applied Chemistry, and Science have been established.

PUBLICATIONS

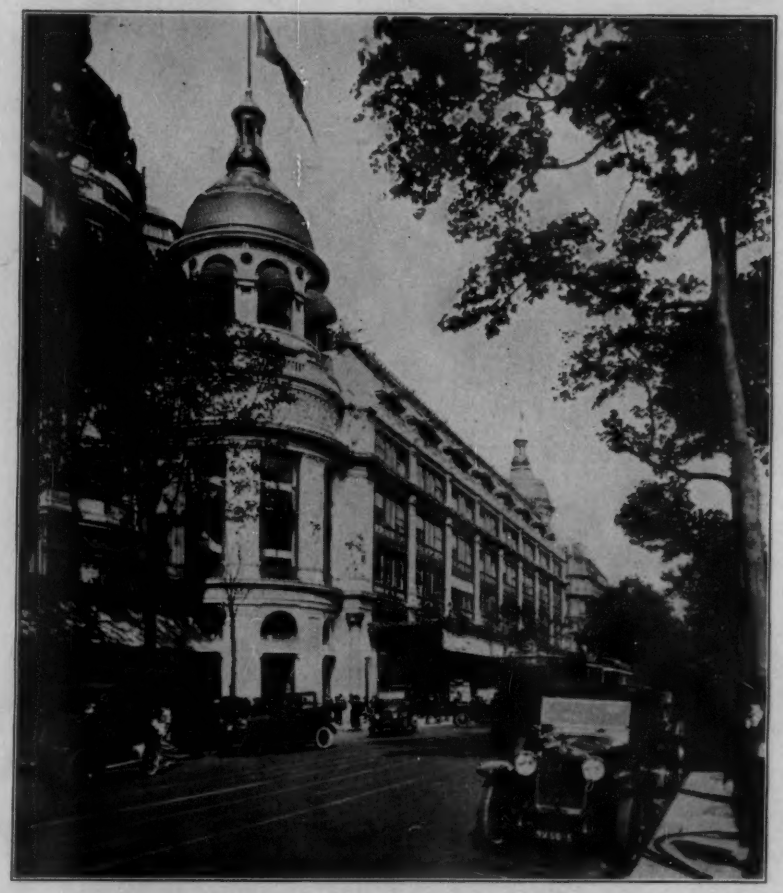
Bulletins of General Information, Courses of Study, Summer Session, Advanced Study and Research; and the Report of the President and the Treasurer.

Any of the above-named publications will be mailed free on application.

For information, address

ADMISSIONS OFFICE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE 39, MASS.

A BOND BETWEEN NATIONS



THE visiting French General stopped his hostess with a gesture as she was explaining rather volubly how to use the Otis Automatic Elevator in her Park Avenue residence.

"Spare yourself the trouble, dear Madam. I shall need your help in finding my way about this vast city; you will have to explain to me a hundred intricacies of your American life, from the best manner of facing a large audience of your compatriots to the best manner of eating your Indian corn, but at least I am as familiar with your elevators as you yourself. Between floors I am at home, for your Otis Elevators are as indispensable to Paris as to New York, no matter how wide the difference between the two cities."

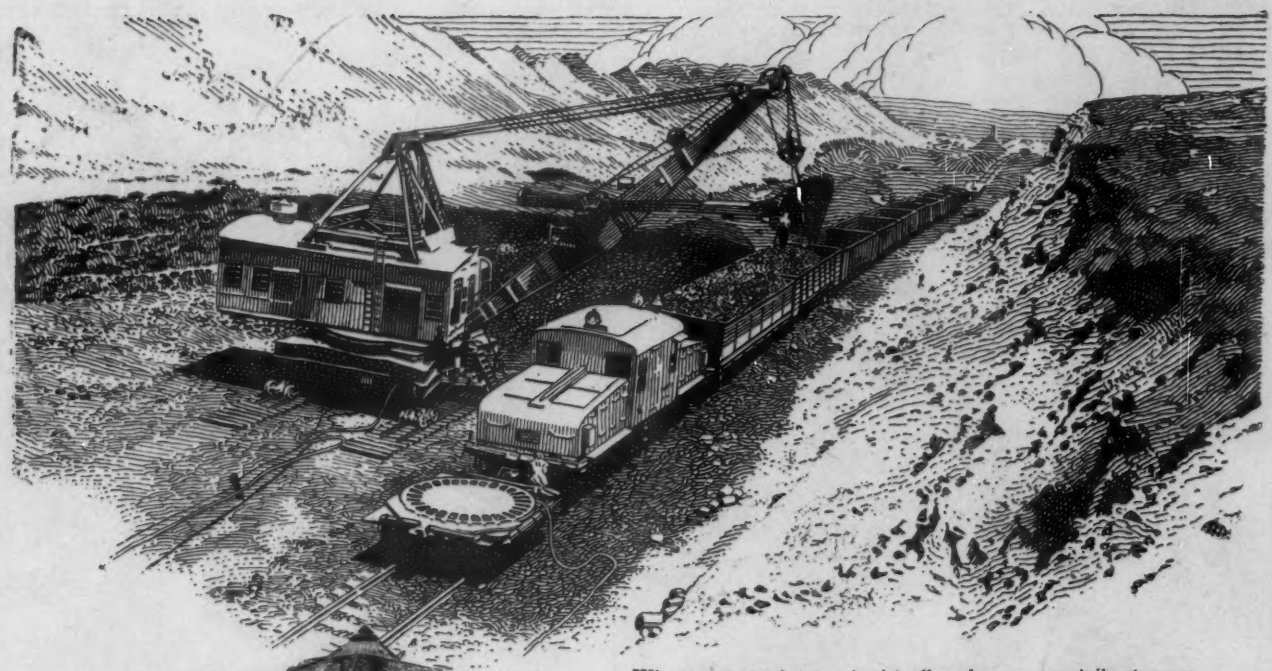
Every city, every separate building presents its own problem, which has been solved, in all parts of the civilized world by the Otis Elevator Company.

European cities do not have the high buildings that are constructed in this country, and therefore their elevator service is not as intensive, but Otis elevators serve the needs of their business life the same as they do in this country.

The Grands Magasins du Printemps illustrated, is one of the large department stores of Paris, and contains fifteen Otis Elevators and seven Otis Escalators. Many French apartments have installations of Otis Automatic Elevators.

OTIS ELEVATOR COMPANY

Offices in all Principal Cities of the World



Where motorized power is virtually unknown, men toil yet accomplish little. The United States has over one-quarter electrical horsepower installed per capita. Japan, leading country of the Orient, has but .04 horsepower. Electric shovel and storage battery locomotive are shown at a completely electrified open-pit coal mine, at Colstrip, Montana.

Work without Toil

Ten or twelve hours a day toils the coolie. If he carries all he can, he moves *one* ton *one* mile in *one* day. For that he receives twenty cents.

Cheap labor! Yet compared with our American worker, receiving at least twenty-five times as much for an eight-hour day, the coolie is expensive labor. In America we move *one* ton *one* mile for less than *one* cent. The coolie, working by hand, accomplishes little; while the American, with electricity's aid, accomplishes much.

Plenty of electricity and cheap electricity —these are two great advantages which America enjoys over the rest of the world. While our present generating capacity is 20,600,000 kilowatts, new developments call for 3,000,000 kilowatts more per year.

To college men and women—potential leaders—will fall the duty of finding more and still more work for electricity, with less and still less toil for our workers. For the task is but begun!

G-E Motorized Power—an ideal combination of electric motor and control properly fitted to the individual task—is at work the world-over, relieving workers more and more for better and more profitable pursuits.

A new series of G-E advertisements showing what electricity is doing in many fields will be sent on request.
Ask for Booklet GEK-1.

95-141DH

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK